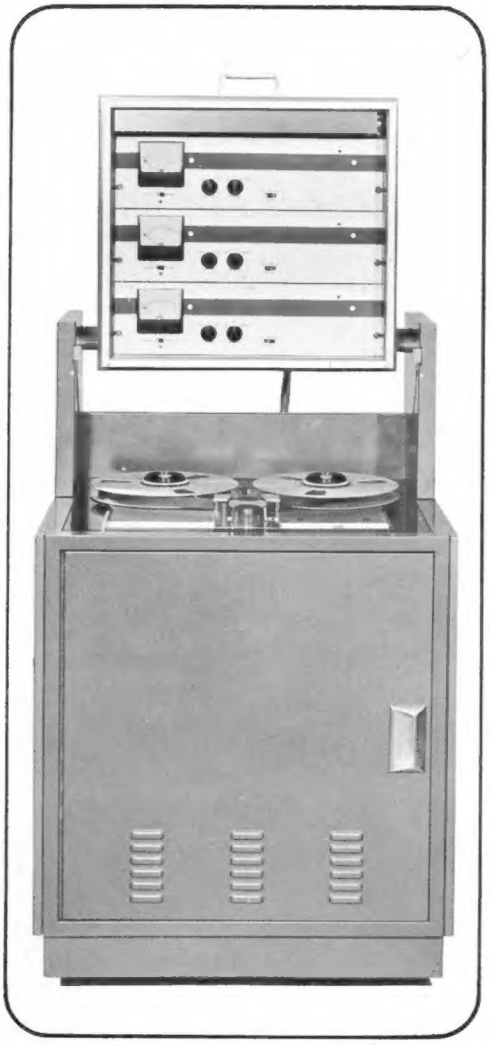

OPERATING AND SERVICE MANUAL

PROFESSIONAL MASTERING SYSTEM

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OPERATING MANUAL CONTENTS

The 3M Professional Mastering System

GENERAL DESCRIPTION

This new tape recording system has been developed by 3M engineers to fulfill the requirements of critical recording studios for improving the quality of master music tapes. Continuing improvements in playback equipment and in records and tapes have revealed deficiencies in original mastering equipment; the 3M Professional Mastering System overcomes these problems, providing improvements you can actually hear.

The 3M Professional Mastering System affords significant improvements over present recording equipment in three areas. Perhaps most important is a major improvement in signal-to-noise ratio, an increase of up to 15 db. The second area of improvement is a new tape drive system that reduces flutter to half that present in other tape transports. Thirdly, the entire system affords an operating and editing ease unmatched by any other tape recorder. Another important improvement which is not readily discerned is an increase in long-term reliability, due to the exclusive use of silicon transistors throughout the electronic assemblies, plus the simplified tape drive system.

Without a doubt, the new 3M Professional Mastering System is a landmark in the history of magnetic recording, setting entirely new standards of quality, especially in the recording of music. While complex in concept, it is surprisingly simple in operation. It actually reduces the problems of the recording engineer while vastly improving the results.

Three different models of the 3M Professional Mastering System are available. Specifications and operating instructions apply basically to all three, as the only difference is in the number of tracks recorded and the number of electronic assemblies. Model #1 is a single channel, 2-track monophonic recorder using standard ¼" tape. Model #2 is a 2-channel, 4-track stereophonic recorder using ½" tape. Model #3 is a 3-channel, 6-track recorder for recording multi-channel stereophonic or stereo and monophonic signals simultaneously. Model #1 or #2 can be easily converted to record additional channels.

INCREASED DYNAMIC RANGE, IMPROVED SIGNAL-TO-NOISE RATIO

The 3M Professional Mastering System improves signal-to-noise ratio and expands the recorded dynamic range of tapes by as much as 15 db over other recorders. These remarkable improvements in sound quality are the result of a revolutionary, yet relatively simple diversity recording and reproducing system and the use of 3M low noise tape. The diversity system feeds the same signal through 2 recording heads, mounted parallel in the same head stack, and records 2 separate, but identical information tracks simultaneously. Every channel in the recorder (one channel for mono, two for simple stereo, or three for multi-channel stereo or stereo and mono together), has two information tracks recorded.

DUAL TRACK MASTER RECORDING

In the 3M Professional Mastering System, one track of a channel is recorded at a normal level, following NAB recording standards. The other track, recording the identical information, records high-frequency signals at a higher level (more recording preamp gain), employing a pre-emphasis curve rising 15 db from 400 cycles to 15,000 cycles. (FIG. 1).

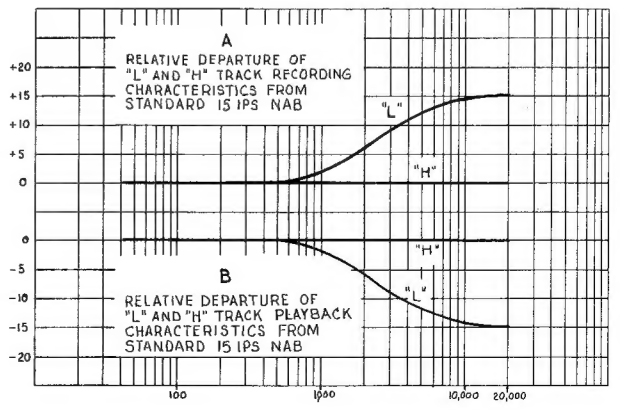


FIG.1

The track recorded at normal level can handle higher signal levels, so it is called the "H" track. It will reach distortion levels in accordance with standard VU meter practice and with NAB response and distortion specifications. The other track, with its pre-emphasized, higher-level signal, is better suited for recording signals of a much lower sound level, so it is called the "L" track. Naturally, this "L" track will go into overload distortion at high-frequency signal levels considerably below "0" VU on the meter. But when reproducing very soft sounds, which are usually lost in tape noise when recorded at normal levels, the "L" track will put out a clean, undistorted signal at a level well above tape noise (FIG. 2).

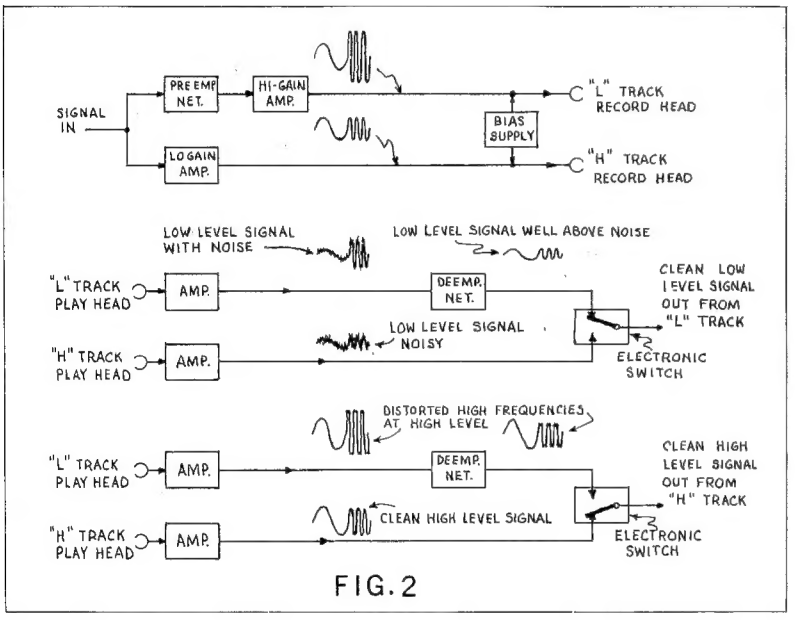


FIG. 2

Once these two tracks are recorded as described, the only remaining problem is to arrange for playing back the proper track--that track with minimum noise or minimum distortion --automatically, and at the proper signal level.

AUTOMATIC PLAYBACK CIRCUITRY

Selection of the proper playback track is dependent upon an electronic circuit which is fully automatic and completely silent in switching from one track to the other. The circuitry is designed and calibrated so that the signals from the "L" track are reproduced up to the point where the signal approaches 1% total harmonic distortion. At this point the output is taken from the "H" track, which has a signal recorded as much as 15 db below the 1% distortion point. Now the level of the output signal can continue rising until it reaches the normal maximum as indicated on the VU meter. This track transfer from "L" to "H" takes just 200 microseconds, so that sudden steep transients of high volume are cleanly reproduced without any audible distortion. When the signal on the "L" track drops below 1% distortion, the electronic circuit automatically transfers the signal from the "H" track back to the "L" track in approximately 10 milliseconds. NOTE: No switching occurs on signals below 400 cycles, as tape noise rarely intrudes on signals below this frequency.

To equalize playback levels of both the "L" and the "H" tracks, there is a de-emphasis network in the play circuit of the "L" track, providing the exact opposite of the pre-emphasis network in the recording circuitry (FIG. 1).

A continuous visual check as to which track is being reproduced is provided by the neon lamp above the "L" track section of the electronic assembly. When the lamp is glowing, the "L" track is being reproduced; when the lamp is out, the "H" track is being fed to the output.

This automatic track transfer system is a completely electronic system; no mechanical relays, switches, etc. are used (FIG. 3). All electronics are solid-state, assuring long term reliability and accuracy of performance. Also, as the diversity recording system is completely electronic, there is no noise involved at any stage or at any frequency, and the system is completely undetectable in use --except for the increased signal-to-noise ratio and the far greater dynamic range of tapes recorded and reproduced on the 3M Professional Mastering recorder.

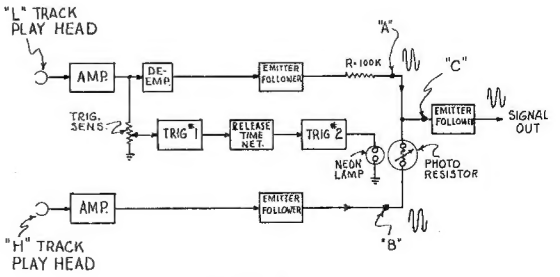


FIG. 3

IMPROVED TAPE DRIVE PERFORMANCE

The tape transport mechanism of the 3M Professional Mastering System is derived from designs used in instrumentation recorders, where standards of timing accuracy and wow and flutter are even more demanding than they are in audio recording. Heart of the patented "Isoloop" tape drive is the differential capstan, which maintains a constant tape tension within the drive and positive contact of the tape against the heads. This is accomplished by creating a difference in the effective diameters of the capstan, so that a smaller diameter capstan drives the incoming tape, while a larger diameter capstan pulls the outgoing tape. The differential capstan diameter is determined by the shape of the two pressure rollers (FIG. 4). In addition, the unsupported tape path is extremely short in comparison to standard design tape recorders. This short path reduces longitudinal oscillation to a new low and eliminates the need for a series of tape guides to maintain a proper tape path.

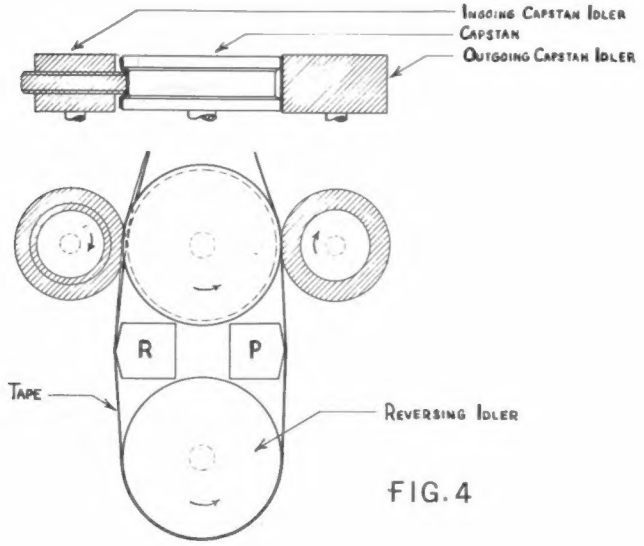


FIG. 4

The drive capstan is of relatively large diameter. On its shaft is a large flywheel, driven by an inelastic tensilized polyester belt which runs from a pulley on the capstan motor shaft. The motor shaft also carries a flywheel. The drive motor itself is specially-designed and has exceptionally high damping.

The "Isoloop" tape drive, short tape path and double-flywheel, belt-driven capstan all aid in reducing the flutter of the tape transport to approximately half that found in other professional tape drive systems.

SIMPLIFIED, MORE RELIABLE TAPE TRANSPORT

The tape transport of the 3M Professional System is designed for simple operation and long-term reliability, with an absolute minimum of maintenance. Employing dynamic braking, it has no idler drives, compliance arms or servo systems to complicate the tape path. The "Isoloop" drive is responsible for this simplification, while also greatly improving flutter and timing performance. Dynamic braking and completely interlocked pushbutton controls guarantee no tape breakage or throwing of tape loops, regardless of operating procedures. Full remote control of the tape transport is easily obtained with an extension panel assembly.

SPECIFICATIONS

SPEED: 15 IPS, with secondary speed of 30 IPS or 7½ IPS

FREQUENCY RESPONSE: 30 to 15,000 cps ± 1 db @ 15 IPS

SIGNAL TO NOISE RATIO: At 15 IPS, greater than 76 db, based on peak record level with no more than 3% total harmonic distortion, to weighted noise using ASA "A" curve.

FLUTTER AND WOW: Less than .04% (all components from 0.5 to 300 cps included); Less than .05% (all components from 0.5 to 5,000 cps included). All measurements made from rewound-replayed tape.

START TIME: 0.5 second to stable motion in PLAY and RECORD modes.

STOPPING TIME: 0.8 second from normal PLAY or RECORD mode.

TIMING ACCURACY: ± 0.10%

REWIND TIME: 60 seconds for 2400 ft.

REEL SIZES: NAB hub. Flange and reel diameters 10½".

EQUALIZATION: Matches frequency vs distortion characteristics of NAB curve for 15 IPS above 1% total harmonic distortion.

TAPE TYPE: Specifications based on 3M tape types 201, 202, or 203. Adjustable bias is factory-set for these tapes.

TAPE WIDTH: ¼" per channel. One channel (2 tracks) - ¼" tape; two channels (4 tracks) - ½" tape; three channels (6 tracks) - ¾" tape.

HEAD COMPLEMENT: Permanently fixed RECORD and PLAY heads, each with 2, 4 or 6 tracks, depending upon unit. No erase head provided (bulk erasure, when necessary, is quicker and provides a quieter tape).

INPUT: Balanced or Unbalanced Bridge, 30K ohms, + 4 dbm bus.

OUTPUT: 600 ohm balanced or unbalanced, + 4 dbm.

POWER INPUT: 60 cycles AC, 105 to 135 volts. Regulated supplies make transformer tap changes unnecessary over this range of line voltages. 50 cycle versions are available.

CONSOLE DIMENSIONS:
WIDTH: 27½" DEPTH: 26" HEIGHT: 60"
WEIGHT: 310 lbs. (transport - 60 lbs., electronic assemblies - 15 lbs. each)

INSTALLATION PROCEDURE

The 3M Master Recording System (console model) is completely ready for operation when it leaves the factory. All electronic and mechanical components are interconnected and all adjustments made. The only exception is the capstan flywheel, which is removed during shipment to prevent damage or misalignment of the capstan. NOTE: Whenever the unit is to be transported a considerable distance, it is recommended that the capstan flywheel be removed and stored in the place provided. For compactness and protection of the transport and electronics, the electronic assemblies fold down over the transport (PHOTO A). (For rack installation, see special sheet attached.)

PHOTO A

SETTING UP

After unpacking the unit, simply raise the electronic assemblies by the handle, allowing them to pivot on the chassis until they automatically lock into place (PHOTO B).

PHOTO B

Remove the flywheel from its storage place in the cabinet (PHOTO C) and place it on the capstan shaft. It must be positioned so that the flat on the shaft faces the hex nut on the flywheel shaft. Tighten the nut with the allen wrench provided (PHOTO D).

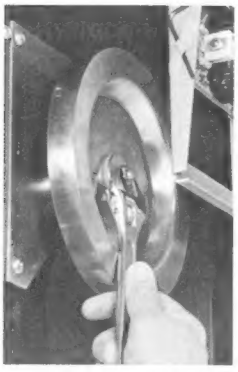


PHOTO C

PHOTO D

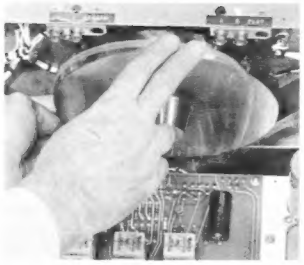


PHOTO E

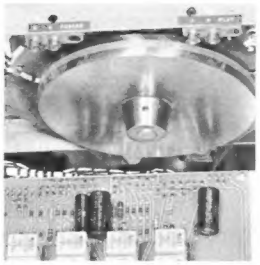


PHOTO F

Now take the drive belt, which is attached to the pulley on the motor capstan, and attach it to the capstan flywheel (PHOTO E). Place it carefully around the crown on the flywheel (PHOTO F). If the drive belt makes a scraping sound, adjust the position of the flywheel on the capstan shaft. CAUTION: Handle this drive belt with extreme care. Do not allow it to be nicked. It is strong and should last indefinitely, but any nick on the edge could cause it to rip and require replacement. The 3M Professional Mastering System is now ready for operation.

RECORDING/REPRODUCING HOOKUPS

All input and output connections and circuitry of the 3M Professional Mastering System are based on standard operating procedures in the recording industry. Therefore this unit should be completely compatible with any normal recording studio setup. Standard 3-wire male and female XL Cannon connectors are used for hooking up the inputs and outputs. If cables are not presently available, they should be made up in conformance to standard practice as to length, shielding, etc.

INPUTS

BALANCED LINE INPUT

To bridge a balanced studio line, connect the line to pins 2 and 3 of the XL Cannon male plug (PHOTO G-1). Connect the ground to pin 1. Input level of -10 to +20 VU can be handled. The load is approximately 30,000 ohms.

UNBALANCED LINE INPUT

An unbalanced line source should be connected to pins 1 and 3 of the connector. Ground should be connected to pin 1. This provides a 30,000 ohm bridging input for any RMS program voltage greater than .2 volt.

OUTPUT

STUDIO LINE

Pins 2 and 3 of the output connector (PHOTO G-2 - an XL Cannon 3-connector male jack) provide a 600 ohm balanced or unbalanced output, + 4 dbm. In the balanced output operation, pin 1 is chassis ground.

For an unbalanced output, connect one side of the line to either pin 2 or 3 and also to pin 1 for ground, connect the other side to the remaining pin. NOTE: The output should always be terminated to assure accurate meter calibration. If line is terminated in 600 ohms, place rear panel Termination Switch (PHOTO G-3) in OFF position. If line is <u>not</u> terminated, place Terminating Switch in ON position to provide the 600 ohm termination required.

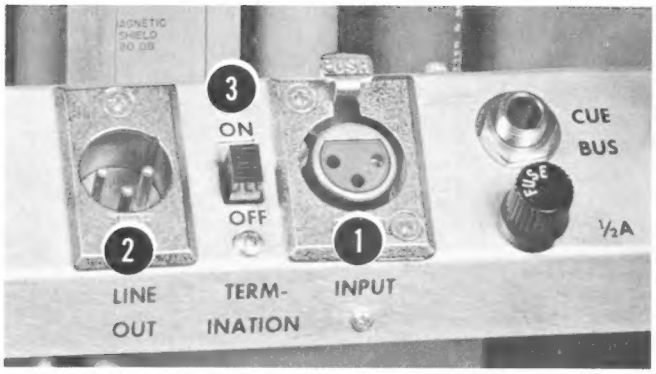


PHOTO G

OUTPUT TO A HIGH IMPEDANCE INPUT

In this hookup, connect the high side of the amplifier input to pin 3 of the recorder output jack. Pins 1 and 2 of the output jack should be strapped, and connected to the ground side of the amplifier input. The Termination Switch should be in ON position to supply the required 600 ohm impedance termination.

POWER CONNECTION

The 3M Professional System uses a 3-wire grounded type power cord, which is connected to the AC socket on the rear of the console cabinet. This connection supplies power to both the mechanical and electronic units of the recorder. Current requirements are 60 cycles AC, 105 to 135 volts (a 50 cycle version is available upon request). The main power circuit is fused with a 5 amp Slo-Blo fuse to protect the recorder from power line surges, etc.

OPERATING CONTROLS --- THEIR FUNCTION AND USE

TAPE TRANSPORT ASSEMBLY

Designed around the patented "Isoloop" drive system, the tape transport of the 3M Professional Mastering System is extremely simple to operate, completely safe and foolproof. Five illuminated feather-touch pushbuttons control all tape movement (PHOTO H). These buttons operate relays, thus providing an interlocked safety system that prevents malfunction. Any button can be pushed in any sequence, at any speed, with complete safety to the tape and machine. These built-in safety factors prevent tape breakage or throwing of a loop. As an additional safety feature, all pushbuttons are inoperative until the tape is threaded in the tape path, breaking the photo-eye circuit.

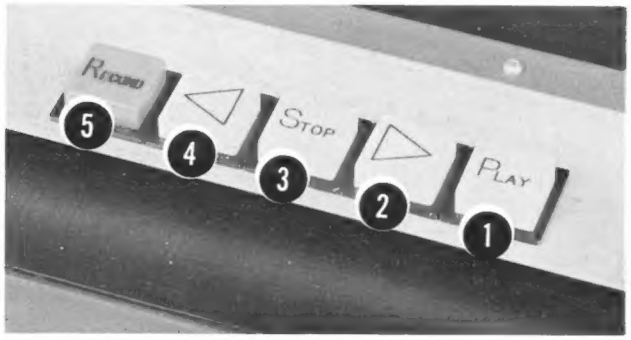


PHOTO H

1. PLAY BUTTON

This activates the tape for normal speed forward motion, either in recording or reproducing. Unit can be placed in PLAY at any time from any tape mode. For recording, PLAY and RECORD buttons must be pushed simultaneously.

2. FAST FORWARD BUTTON

Activates high speed tape advance, and may be used no matter what mode of operation tape is in. In FAST FORWARD operation tape lifters are activated and head shield opens. The PLAY head tape lifter may be manually disabled to allow tape to be heard. When the STOP button is operated from this mode, dynamic braking is used to stop tape, then a slight holding torque is applied to maintain tape tension (SEE NOTE 1).

3. STOP BUTTON

This stops the tape travel from any mode of operation. This button also indicates when unit is ready to operate, as it is illuminated when the transport is energized (power is on and tape is threaded in tape path). Without tape in tape path, the unit will not operate and button will not be lit. When STOP button is activated while tape is in high speed travel, dynamic braking is applied until tape stops, then unit goes into STOP mode with a light holding torque applied by both motors to maintain tape tension.

4. REWIND BUTTON

Tape may be placed into high speed rewind from any other mode of operation, even from FAST FORWARD, without danger of tape breakage. Tape lifters on both heads operate during high speed rewind, and the head shield opens. The PLAY head tape lifter may be manually disabled if you want to hear the tape.

5. RECORD BUTTON

This connects the recording circuits to the RECORD head. To operate, the button must be pushed at the same time as the PLAY button is pushed. Stopping the tape, or changing the tape mode of operation, automatically deactivates the recording circuit, and the RECORD and PLAY buttons must be pushed again to resume recording. To complete the recording circuit, the recording amplifier switch on the applicable electronic assemblies must be in RECORD.

NOTE 1: A photocell and directional "flag" under the take-up reel turntable control the dynamic braking and electrical switching when unit is taken out of FAST FORWARD or REWIND operation. Due to friction drag this "flag" acts as a directional sensor, determining in which direction the tape was traveling. The photocell then activates relay control circuits which place the transport in either FAST FORWARD or REWIND, then in STOP mode, depending upon original direction.

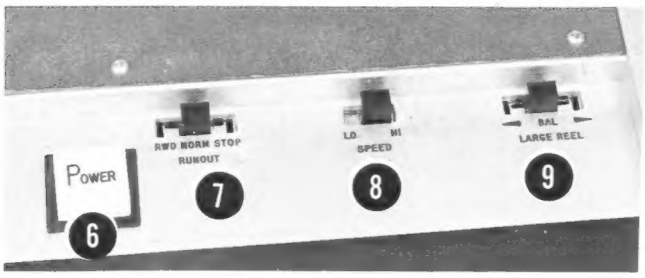


PHOTO I

6. POWER SWITCH

AC power to the entire recorder is controlled by this switch. Note: Tape transport mechanism will not be energized and STOP button will not light until tape is threaded into tape path. CAUTION: Do not turn off Power Switch when unit is in fast tape travel, as a tape loop could be thrown because the dynamic braking will not operate.

7. RUNOUT SWITCH

This switch controls the actions of a photo sensor in the tape path. It can be set to automatically stop the tape, or to automatically rewind the tape. The switch circuits will also automatically start another tape machine. To activate the circuits, punch a ¼'' hole in the tape, 3/8'' above the bottom, at the point where one of the automatic operations is desired. When that hole passes the sensor, the tape will automatically stop, or stop and rewind, depending upon the position of the switch. When the switch is in the center, or normal, position, the automatic feature is inactive. When no hole is punched in the tape, the unit will automatically shut off when the tape runs out.

8. SPEED SWITCH

Used to select either of the two speeds at which the machine operates. Depending upon unit, the speeds are: LO - 7½ IPS, HI - 15 IPS; or LO - 15 IPS, HI - 30 IPS.

9. BALANCE SWITCH

This 3-position switch changes motor torque factors to compensate for reels of different weight and/or size. When both reels are identical, the switch remains in the middle, or BALANCED position. If the left reel is larger or heavier, the switch should be in the left position. If the right reel is larger or heavier, place the switch in the right position.

REMOTE CONTROL

PHOTO J

The accessory remote control box (PHOTO J) duplicates the action and function of the five operating pushbuttons, and also incorporates a run-out light to indicate when tape has run out and unit has stopped. To use, simply connect the cable to the remote control outlet (PHOTO K). No jumpers or plugs are required when the unit is not connected, as the remote circuit parallels internal circuits.

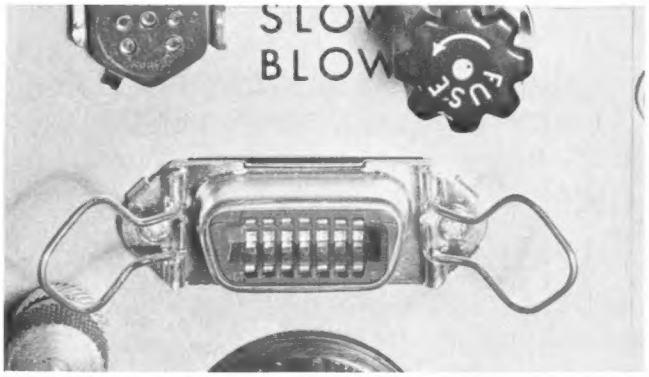


PHOTO K

10. REVERSING IDLER

Tape is threaded around this free-wheeling idler, which helps provide an extremely short path of unsupported tape. Ridges in the idler provide for air passage during hi-speed tape movement, so that the tape hugs the idler.

11. EDIT CODE

The tri-colored bars and dots on top of the reversing idler are used for precision editing, as described in the section on EDITING.

12. RECORD HEAD

The head stack provides for recording on 2, 4, or 6 tracks, depending upon the unit. Permanently aligned.

13. PLAY HEAD

Plays 2, 4, or 6 tracks, depending upon configuration. Permanently aligned.

14. TAPE LIFTERS

These automatically move tape away from heads during hi-speed tape travel to reduce head wear and cut "chatter". When desired, PLAY lifter may be manually disabled so that tape will run against PLAY head and tape can be heard for cueing, etc.

15. TAPE LIFTER LEVER

Turn manually to disable PLAY lifter and drop tape against head.

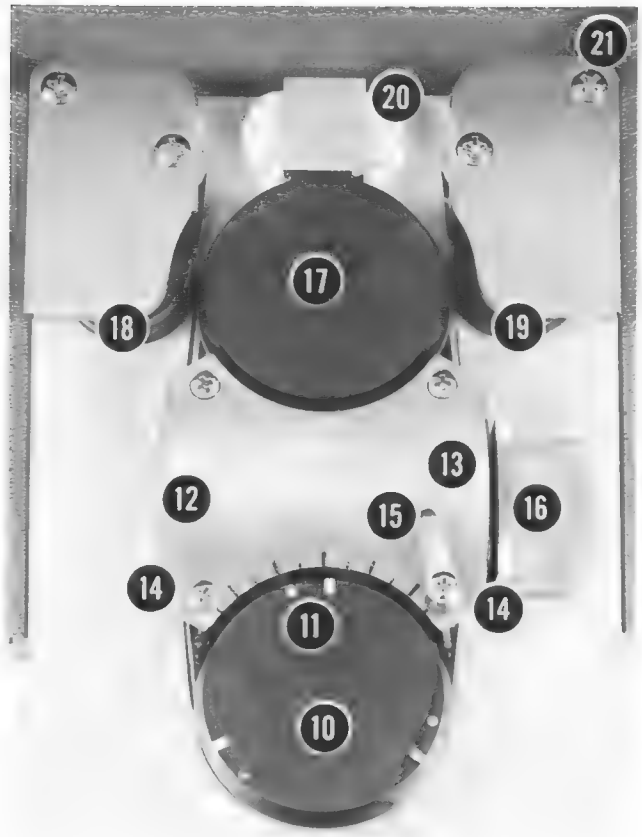


PHOTO L

16. HEAD SHIELD

Provides for hum reduction. Automatically drops away from head during hi-speed tape travel and whenever tape is removed from tape path. This allows easy removal of tape for editing, etc. As soon as tape is dropped into tape path, head shield closes.

17. CAPSTAN

This differential capstan is the basis of the patented "Isoloop" system for transporting tape with extremely low flutter and wow. Its function and operation is described on page 5.

18. CAPSTAN IDLER (INCOMING TAPE)

This idler is designed to feed tape into the drive system at a slightly lower rate than it is taken out.

19. CAPSTAN IDLER (OUTGOING TAPE)

This idler pulls the tape through the head assembly at a slightly higher rate than the tape is fed in. This maintains a constant tape tension across both heads, but the tension does not exceed the stretch capabilities of the tape. To be sure tension is constant, the feed idler moves the tape against the capstan a fraction of a second prior to the action of the takeup idler whenever PLAY function is activated.

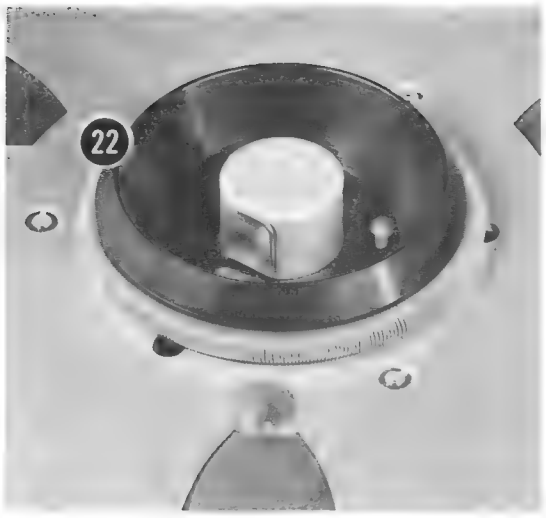


PHOTO M

20. PHOTOELECTRIC EYE

This electric eye circuit across the tape path provides both convenience and safety. Whenever the tape breaks the beam, a slight holding torque is applied to the reels to maintain tape tension. When there is no tape in the path, the reel motors are deenergized, the tape turntables are free-wheeling, and the head cover opens. This allows for easy removal of the tape for splicing. Also, when the end of the tape runs out, the motors automatically stop, preventing tape whip-around.

21. EDIT POST

A sharp edge puts a crimp in the tape when it is pressed against the post. When used in conjunction with editing code on the reversing idler, it provides for easy, trouble-free editing.

22. REEL HOLDERS

Standard reel holders (PHOTO M) are supplied for holding down 10½" NAB reels. Pressing down on reel hub center causes spring to expand, holding reel down. A slight pressure on side of clamp releases the spring so that reel can be removed.

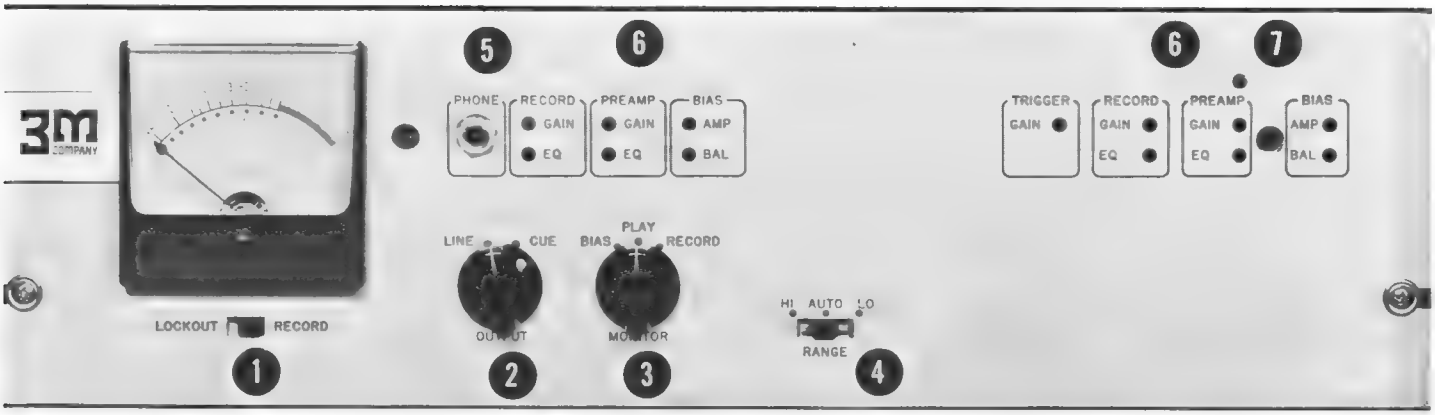


PHOTO N

ELECTRONIC ASSEMBLIES

1. RECORD AMPLIFIER SWITCH

This switch in LOCKOUT position prevents activation of the record amplifier. This eliminates any possibility of over-recording previously recorded tape if RECORD button on transport is accidentally activated.

2. OUTPUT SWITCH

Used to connect signal from PLAY head to either LINE output (in LINE position) or HEAD PHONE jack (in CUE position) on rear of electronic assembly.

3. MONITOR SWITCH

Connects VU meter and Phone Output Jack to one of three circuits. In RECORD position connects signal from RECORD head; in PLAY position connects signal from PLAY head; in BIAS position measures amplitude of BIAS current. (NOTE: This position inactive in some models.)

4. RANGE

Provides a choice of channels in playback. In HI position, only the signal from the "H" track head is being reproduced; in LO position only the signal from the "L" track head is being reproduced. When in AUTO position, which is normally used, the electronic switching circuit automatically selects the circuit to be reproduced, depending upon distortion and noise level.

5. PHONE OUTPUT

A signal is available at all times from this connection. When MONITOR switch is in RECORD position, incoming signal is monitored before taping; when switch is in PLAY, signal at PLAY head (from tape) is provided.

6. RECORD/PREAMP/BIAS/TRIGGER ADJUSTMENTS

These screwdriver adjustments are used in electronically aligning the assembly (when desired), as described in section on ELECTRONIC ALIGNMENT PROCEDURE. Recorder is factory aligned for optimum performance, and should rarely require realignment. Adjustable bias is factory-set for 3M tape types 201, 202, and 203.

7. NEON LAMP

This neon lamp indicates which channel is being fed into the LINE output. When the lamp is glowing, the "L" track is being reproduced; when lamp is out, the "H" track is being reproduced.

PANEL LIGHT SWITCH

Mounted beneath lamp at top of cabinet. Lamp illuminates all electronic chassis and tape transport.

ELECTRONIC ALIGNMENT PROCEDURE

The 3M Professional Master Recorder is factory-aligned for peak performance. Because all electronics are solid state silicon transistors, this alignment should remain correct over a long period. All alignment controls are behind a removable panel on the front of the electronic assembly, and are screwdriver adjusted (recommended is a TV alignment tool). To remove panel, simply pull off.

For purposes of critical alignment, a special 3M Master Alignment Tape is supplied with each recorder. PLAY circuits can be realigned using only this tape; RECORD circuits require an audio generator.

When realigning the unit, each electronic assembly must be adjusted individually. Alignment procedure for each channel is as follows:

PLAY CIRCUIT ADJUSTMENTS:

1. Place Monitor Switch in PLAY. (Make sure output is properly terminated.)
2. Play the portion of the alignment tape where a 400 cps signal is recorded at "0" VU level.
3. Switch the Range Selector to LO.
4. Adjust the LO track Preamp Gain screw so that the VU meter reads "0".
5. Switch the Range Selector to HI.
6. Adjust the HI track Preamp Gain screw so that the VU meter reads "0".
7. Play the portion of the alignment tape with a 12,000 cps signal recorded at "0" VU.
8. Leave the Range Selector in HI.
9. Adjust the HI track Preamp Equalization to read "0" VU.
10. Play the portion of the alignment tape with a 12,000 cps signal recorded at -15 VU.
11. Switch the Range Selector to LO.
12. Adjust the LO track Preamp Equalization until manually switching Range Selector from LO to HI and from HI to LO shows no difference in VU reading or in sound level output.
13. Set Range Selector switch to AUTO.
14. Adjust the Trigger Gain until the neon light just flashes.

ALL PLAY circuits are now adjusted for maximum performance. Follow the same procedure for each channel of the recorder.

RECORD CIRCUIT ADJUSTMENTS

1. Connect an audio generator to the Line Input of the electronic assembly.
2. Set Monitor Switch to RECORD.
3. Set Range Selector Switch to LO.
4. Set audio generator to 400 cps and adjust output to read "0" on the VU meter.
5. Set Monitor Switch to PLAY.
6. Place recorder into RECORD mode by simultaneously pressing the RECORD and PLAY buttons on the deck.
7. Adjust bias for peak signal output on both HI and LO tracks.
8. Adjust the Record Gain on both the LO and HI tracks to read "0" VU.
9. Set audio generator to 10,000 cps at "0" VU input.
10. Readjust bias on HI track for "0" VU output.
11. Set audio generator to 15,000 cps and adjust HI track Record Equalization for maximum flat response.
12. Adjust generator output to -15 VU and repeat steps 8 thru 11 on LO track.
13. Slight changes may be made in the bias adjustment of either track to achieve overall flat response.

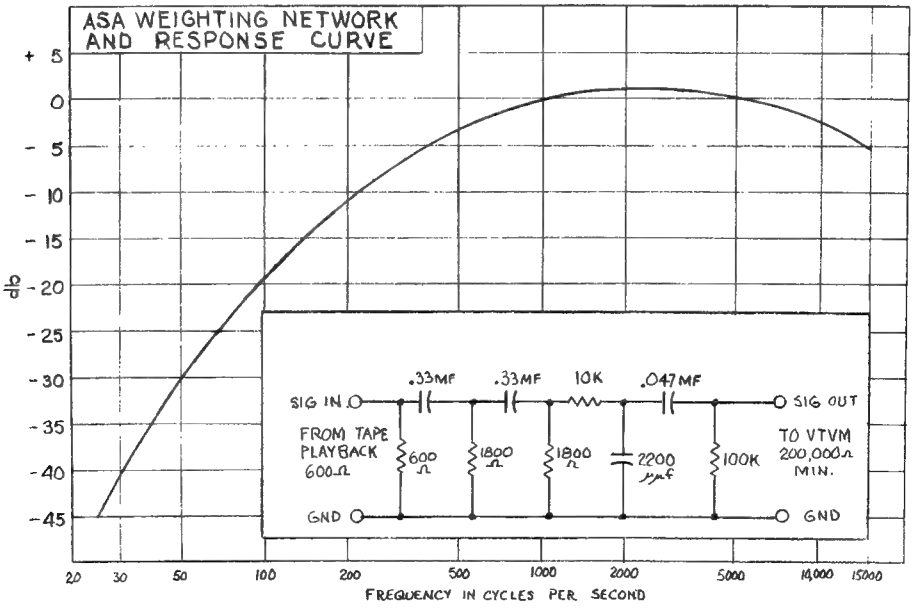
The RECORD circuits are now adjusted for peak performance. Follow the same procedure for each channel of the recorder.

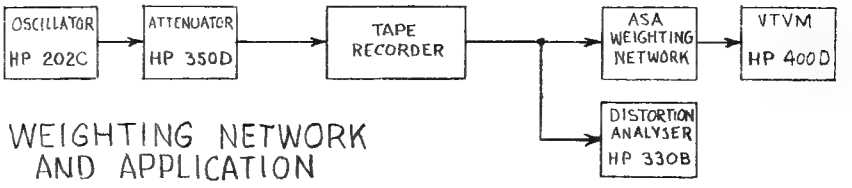
NOTE: The above alignment should be made using a length of tape from the batch to be employed for subsequent recording, whenever possible, to assure maximum uniformity and perfection of end product.

DYNAMIC RANGE MEASUREMENT AND ADJUSTMENT

For these tests, the apparatus shown in the drawing "Weighting Network and Application" or equivalent is required, connected as shown in the block diagram.

1. Be certain the 3M Recorder is properly aligned as outlined previously.
2. Place the 3M Recorder termination switch in the "ON" position.
3. Set the Range Selector Switch to "AUTO" and the Monitor Switch to "RECORD".
4. Set the 202C oscillator to 400 cycles.
5. Set the 350D attenuator to 16 db loss.
6. Adjust the variable output of the 202C to read "0" VU on the 3M Recorder meter.
7. Start the recorder in the "RECORD" mode, using carefully degaussed low noise tape.
8. Set the Monitor Switch to "PLAY". The meter should continue to show "0" VU.
9. Measure the distortion with the 330B. It should be approximately 1% total harmonic.
10. Remove 6 db of loss from the 350D. (-16 to -10).
11. Again read the distortion. Total harmonic distortion should be 3%. (This is at +6 VU level through the recorder.)
12. Change the oscillator frequency to 1000 cycles.
13. Observe the reading on the 400D vacuum tube volt meter.
14. Cut off the input to the 350D by disconnecting the oscillator.
15. Read the residual noise from the 400D. A figure of 76 db below the previous reading should be observed. If the reading shows less spread than this between maximum (3% distortion) signal and noise, degauss the record heads and adjust the noise balance pot on the HI track for minimum distortion as measured at +6 VU on 400 cycles. Reset the record and playback gain potentiometers if necessary after minimizing distortion in this manner to provide 3% distortion at +6 VU and again measure the dynamic range as outlined above. At the discretion of the user, the 3% distortion point may be changed to occur one or two db above +6 VU in order to provide greater peak signal reserve since this system has such a wide dynamic range. It must be borne in mind, however, that such readjustment must be carried throughout an entire system where more than one machine is involved in order to provide interchangeability of tapes.





WEIGHTING NETWORK AND APPLICATION

GENERAL OPERATING PROCEDURES

THREADING

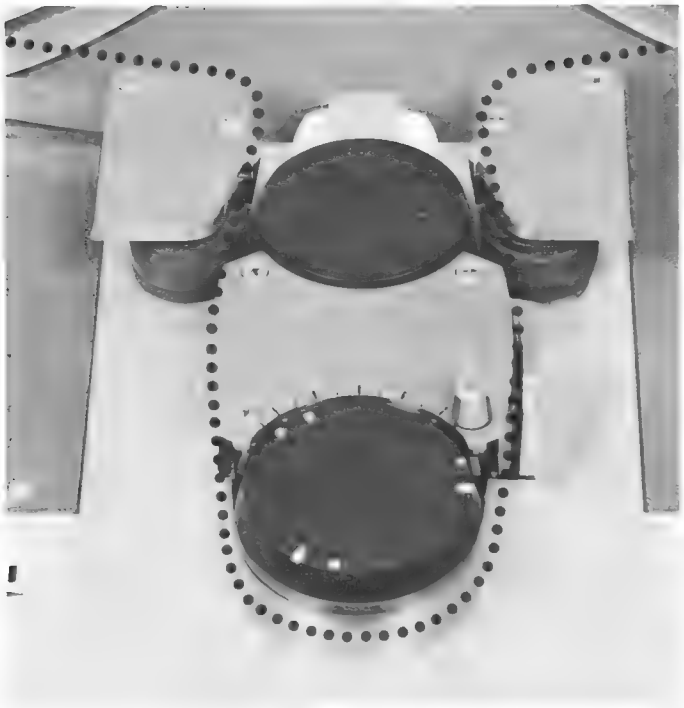


PHOTO O

Threading the recorder is extremely simple, as there are no compliance arms or other mechanical devices. Also, there is no tension on the tape until it breaks the photoelectric circuit in the "Isoloop" assembly, so the reels are free-wheeling. To thread, first push the POWER button to turn the machine on. Take the tape from the supply reel, drop it between the capstan and the incoming idler, past the RECORD head, around the Reversing Idler, past the PLAY head (the Head Shield is open), between the capstan and outgoing idler, then onto the takeup reel. As the tape breaks the photoelectric circuit after the outgoing idler, a slight holding torque is applied which takes up any slack in the tape. The unit is now ready to operate.

MONITORING

The 3M Professional Mastering System affords full monitoring facilities utilizing completely independent circuits. The headphone jack on the front panel is always "live" and selection of circuits is controlled by the MONITOR switch. To check the incoming signal, before recording, place switch in RECORD position; to hear signal from tape, place switch in PLAY position. There is also a headphone jack on the rear panel of the electronic assembly, which is controlled by the OUTPUT switch. When the switch is in CUE position, the signal from the PLAY head is available at this jack.

High impedance headphones should be used for monitoring. Through use of the RANGE switch, you may monitor from the PLAY head either the "L" track, the "H" track, or the automatically switched signal from both tracks. As the AUTO position is the one which will normally be used, it is suggested that this signal be monitored.

TAPE ERASURE

Tape erase facilities are not provided on the 3M Professional Mastering System. Normal erase head circuitry, while satisfactory on normal recorders is not efficient enough for use on the 3M recorder. To take full advantage of the increased dynamic range and lower noise level provided by the 3M recorder, all recording should be done with fresh, virgin tape, or tape that has been bulk erased.

TAPE EDITING

Due to the basic simplicity of the "Isoloop" drive system, plus the advantages of dynamic braking, automatic tape tensioning and release, and the unique editing feature of the reversing idler, tape editing is extremely fast, accurate and easy.

To locate the cutting point, follow the normal procedure of "rocking" the reels to and fro by rotating the reel knobs. Because there is only a slight holding torque on the motors, this requires only very light effort. Once the cutting point has been found, proceed as follows:

Note the position of one of the colored edit spots on the top of the reversing idler in relation to one of the markings on the scale (PHOTO P1). Now move the tape forward by hand approximately 2/3 of a turn of the idler until an edit line of the

PHOTO P1

PHOTO P2

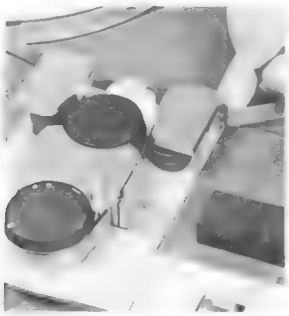


PHOTO P3

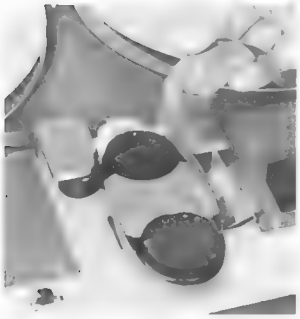


PHOTO P4

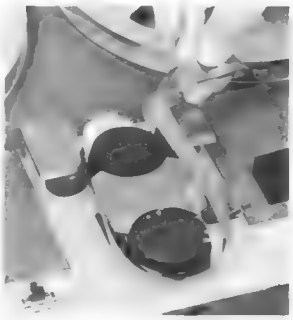


PHOTO P5

same color as the spot is opposite the same scale marking (PHOTO P2). Now use your forefinger to press the tape against the sharp edge of the edit post (PHOTO P3). This puts a light crimp in the tape, precisely marking the point of cutting (PHOTO P4). Lift the tape out of the path, deenergizing the reel motors and allowing the tape to be completely slack (PHOTO P5). After making the splice, simply drop the tape back in the path. The holding torque is again applied automatically. You are now ready to advance tape to the next editing point.

This simple, yet highly precise editing system eliminates completely the need for grease pencils and other makeshift marking devices which require the tape to be cleaned after editing. NOTE: When extensive editing is to be done, it is suggested that the Record Amplifier switches on the electronic assemblies be placed in LOCKOUT position to eliminate any possibility of accidental damage to the signal because of inadvertant pressure of the RECORD button.

ROUTINE MAINTENANCE

TRANSPORT

The design simplicity of the patented "Isoloop" tape drive reduces maintenance problems of the tape transport to a minimum. Without mechanical brakes, compliance arms or other mechanical devices found on other tape recorders, these trouble points are eliminated. All rotational elements of the tape transport are mounted in precision ball bearings which do not require any attention. Aside from routine cleaning of the drive belt and its running surfaces, heads, pressure rollers and other tape contact points, plus normal dusting, the 3M Professional Mastering System should not require attention or service for more than 1000 hours of use.

Professional recording practice calls for the heads to be cleaned before each recording session. The easy accessibility of the heads on the 3M Recorder make this a simple task, using alcohol or other head cleaning fluids on a cotton swab. Regular cleaning of the capstan, reversing idler, tape lifters and tape guides is advised, although new 3M tapes leave far less oxide on these parts than previous tapes.

ELECTRONICS

Silicon transistors are used in all electronic components of the 3M Professional Mastering System, thus eliminating all problems inherent in vacuum tube circuitry. Normally, no maintenance is required for the electronic assemblies. Also, the use of conservatively-rated plug-in component boards for each major function (record, preamp, bias power, output and regulated supplies) allows fast, easy servicing in the event of trouble -- simply replace the malfunctioning board.

HEAD DEMAGNETIZATION

As record and play heads have a tendency to become magnetized over a period of use, it is recommended that they be demagnetized regularly. Ideally this should be done before each recording or editing session. Use one of the commercially available demagnetizers according to instructions.

SERVICING SUGGESTIONS

MECHANICAL

FLUTTER HIGHER THAN SPECIFIED

1. Insufficient pressure, ingoing or outgoing rubber capstan idler.	Adjust position of corresponding solenoid after removing deck cover plate. Be certain solenoids seat fully when energized after adjustment.
2. Dirt on capstan, reversing idler or capstan idlers.	Clean with swab moistened in alcohol.
3. Belt slipping	Loosen screws holding capstan motor mounting plate to transport reinforcing bars. Slide motor toward rear of machine and retighten. Required tension is not critical. It must be sufficient to prevent slippage so that motor stalls if flywheel is stopped by hand when power is on. It is possible to generate other flutter components if tension is excessive.
4. Belt scraping	If edge of belt scrapes on frame, adjust height of capstan flywheel.
5. Dirt on belt, capstan flywheel or motor drive pulley.	Motor pulley is most likely to cause flutter from caked dirt on surface. Remove felt pulley wiper pad. This is held in place on motor mounting plate between motor and printed circuit board by a single clamping screw. Loosen screw to remove clip holding pad and replace after cleaning with stiff dry brush. Clean belt and capstan flywheel with swab moistened with alcohol.
6. Scraping reels.	If flanges of reels rub excessively against tape or scrape against deck, flutter can result. Check for bent flanges. If persistent, check height of platens on torque motors. To adjust height, transport cover plate must be removed. Loosen set screw on hub of platen and pull platen from shaft. A screw head is visible at the bottom of the platen hole after it is removed from the shaft. Using 8-32 Allen wrench, turn screwhead clockwise to lower platen toward motor or counter clockwise to raise it. Replace platen as far as it will go, making certain that the set screw is aligned with the flat on the motor shaft. Then tighten set screw.

7. Capstan bearing damage.	A highly unlikely source of flutter, but possible to damage capstan bearings by rough shipment of machine with flywheel in running position. Avoid damage during shipment by removing flywheel and stowing on post provided.
8. Reversing idler bearing damage.	Not likely to occur except from sharp blow against idler. Bearings may be replaced as follows: Pry off cap with knife blade inserted just under bevelled edge. Remove center screw to slip off idler and bearing assembly. If periphery of idler has not been damaged, bearings can be replaced, otherwise replace entire assembly.

CONTROL MALFUNCTION

1. Reel hubs rotate at approximately 50 RPM when power is on but no tape threaded.	All following adjustments require removal of transport cover plate. (1) Lamp LP-8 not lit. Replace. (2) Light path from LP-8 to light switch PQ-3 interrupted by dirt or piece of scrap tape. Clean the path. PQ-3 is on the outgoing side of the capstan. (3) Light pipe above PQ-3 misaligned so that insufficient light strikes PQ-3. Loosen set screw in rear wall of capstan block and readjust.
2. Coasting to stop from both directions.	Light path from LP-7 to both PQ-1 and/or PQ-2 is interrupted by dirt, a piece of scrap tape in the paths to both light switches or a burned out lamp, LP-7. Clean light paths and be certain mask is free to swing to either stop position by rotation of take-up reel hub.
3. Coasting to stop from forward direction, braking OK from rewind direction.	Permanent interruption of light path from LP-7 to PQ-1 caused by dirt or tape scrap or drag mask sticking over PQ-1.
4. Coasting to stop from rewind direction only. Braking OK from forward direction.	Permanent interruption of light path from LP-7 to PQ-2 caused by dirt or tape scrap or drag mask sticking over PQ-2.

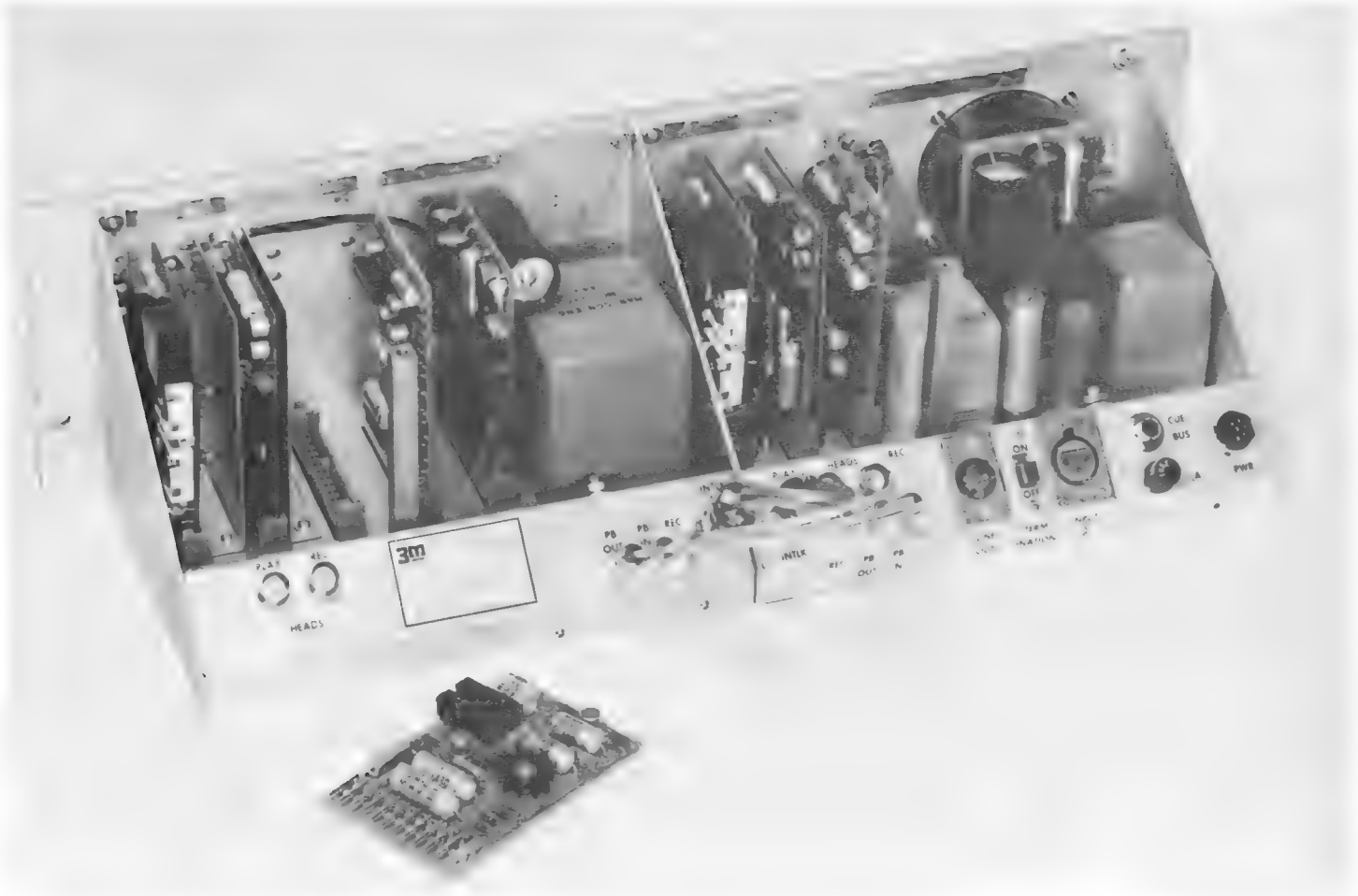
5. Tape throws small slack loop when starting in "PLAY".	Adjust ingoing capstan idler pressure and/or air escape port at head of dash pot cylinder for more gentle action. Be sure outgoing idler is functioning no sooner than 0.2 second after activation of "PLAY" mode.
6. Shield cover door remains open after tape stops.	Adjust position of "LOCK OPEN" switch SW-10.
7. Tape lifter sluggish.	Adjust lifter solenoids and check linkages for ease of operation.
8. Tape runs slack when shuttling at high speed.	Unbalanced reels. Set balance switch to proper position for particular reels employed.

ELECTRONIC

VARYING NOISE

1. Once per turn of supply reel.	Improperly degaussed reel. Follow manufacturer's instructions meticulously in use of degausser. On ½ and ¾ inch tape degaussing should be done on one side and then repeated with the reel turned over.
2. Crackling noises and thumps.	Magnetized record head. With power to electronics turned off, degauss all heads. If a head degausser is not available, a tape degausser may be used. Starting with degausser a couple of feet from heads, turn on degausser power, slowly bring the most active part of the degausser as close as possible to the heads and without touching heads or machine slowly remove degausser. Be careful to avoid any mechanical shock to heads during the entire process. Turn off degausser only after it is several feet from heads. After degaussing, run tape in "RECORD" mode and check playback for residual noise. Adjust the noise balance potentiometer (R8) on each bias board for minimum noise. If a harmonic distortion meter is available, set potentiometer R8 for minimum distortion at +6 VU at 400 cycles on each track, LO and HI. Read Dynamic Range and Adjustment section.

3. High frequency loss.	Be certain heads are clean and faces have not been mechanically damaged. Clean heads with swab dipped in alcohol. If condition persists, check electrical alignment as outlined under circuit adjustments. Circuits should always be set for optimum performance with the particular tape in use. If rubber capstan idlers are not pressing tape to capstan with sufficient force, the tape may be loose enough within the loop to cause variable high frequency loss as well as high flutter. If loss is variable and only on edge track, examine tape for rippled edge.
4. Meter reading too high or too low.	Check termination conditions. If output of electronics is externally terminated be certain termination switch is in OFF position. Otherwise meter will read low. If not externally terminated (if working into bridging or high impedance circuit), be sure switch is in ON position otherwise meter will read too high.



CIRCUIT DESCRIPTION: RECORDING AND PLAYBACK ELECTRONICS

Reference Drawing Number 1995-325

GENERAL

The above referenced drawing is a schematic of the entire record and playback circuits for a typical channel. In a multiple channel recorder, all channels are identical, each being according to this schematic.

When the transport buttons are operated to place the machine in the "RECORD" mode, the transport applies 26 volts DC to the cable connected to J25 ("PWR") on terminal B. With the "RECORD-LOCKOUT" switch SW3 in the record position, this causes K1 and K2 to operate, the latter through the "INTLK" cable connection between J16 and J15.

The electronic chassis is built in two assemblies, mechanically joined behind the front panel. Viewed from the rear, the right hand unit contains all the elements bounded within the heavy line designated as "HI CHASSIS" C-1995-289 on the schematic.

All the apparatus on the left hand chassis is bounded within the heavy line designated "LO CHASSIS" C-1995-290.

The "HI" chassis provides the equipment required to record and playback the signals of high level and operates in accordance with standard NAB specifications for signal levels and equalization. It contains a plug-in record amplifier board ("H" RECORD, 1995-305), a plug-in bias supply board ("H" BIAS, 1995-301), a plug-in playback and output amplifier board ("H" PB and OUTPUT, 1995-306) and a power supply comprised of a power transformer T-3 and regulator transistor Q2A mounted on the frame and associated with a plug-in board ("H" POWER, 1995-302). This supply provides 18 volt power for the "H" playback and output board, the "L" playback and switch board and the trigger board. Additional power for the Record and Bias boards is obtained from the "LO" chassis.

The "LO" chassis provides the equipment required to record and playback the signals of low level. These circuits are specially equalized with high frequency pre-emphasis in recording and equivalent de-emphasis in playback to provide greatly reduced tape noise during reproduction of recordings. This chassis contains a plug-in record amplifier board, ("L" RECORD, 1995-303), a plug-in bias supply board ("L" BIAS, 1995-301), a plug-in playback and track switching board ("L" PB and SWITCH, 1995-307), a plug-in switching control board (TRIGGER, 1995-300), and a power supply comprised of a power transformer T4 and regulator transistor Q2B mounted on the frame and associated with a plug-in board ("L" POWER, 1995-304). This supply provides 26 volt power directly to both record boards, and through record relay K2, when operated, to both bias amplifier boards. This power supply also contains a high voltage DC system furnishing regulated 130 volts and 91 volts to the "L" playback and switch board.

OVERALL OPERATION

The input signal is connected to the Signal Input plug. This is a bridging input with an impedance of 30,000 ohms, appearing between terminals 2 and 3. This may be used as a balanced input or unbalanced with either terminal 2 or 3 grounded. Terminal 1 is a ground connection for shielded leads. The main frame of the recorder should be connected by a heavy conductor to system ground. The three wire power plug on the transport may be found to furnish an adequate ground for this purpose.

The signal to be recorded passes through T1. From terminal 3 of this transformer, it is fed to both record boards. From terminal 1, it is also fed to the calibration plug which then feeds it at proper level to switch SW1, which, in the "RECORD" position selects the input signal for monitoring.

After amplification and some equalization in the "H" record board the signal passes through the contacts of K1 which are made between 6 and 4 when this relay is operated. It then passes through the "H" bias board and is mixed with high frequency bias current from the bias amplifier. The bias frequency is 250 KC. The mixture is then applied to the record head for the "H" track via J21.

Simultaneously the signal applied to the "L" record board is amplified and pre-emphasized in accordance with the special noise reduction curve. It then passes through contacts 9 and 5 of relay K2 which are closed when this relay is operated and is fed through the "L" bias board where it is mixed with high frequency bias current from the bias amplifier. The mixture is then applied to the record head for the "L" track via J11.

The source of 250 KC bias for both bias amplifiers is located in the tape transport. It is supplied to the bias boards through pin H of J25, with ground return on pin E, and is active only when the recorder is in the recording mode.

During playback the H track is reproduced by a head connected to J20. This feeds the signal to the low noise preamplifier and equalizer comprised of Q1 through Q3, which provides an output fully equalized for flat over-all response. The output level is adjusted by the gain control and fed via C7 and G1 to the electronic switch. If the switch has selected the "H" track, the signal is then fed through Q5 and Q6 in the "L" PB and SWITCH board via G10 to the "MONITOR" switch SW1. If this switch is in the "PLAY" position the signal is then applied via C6 to the output amplifier comprised of Q4, Q5 and Q6. T2 then feeds the output amplifier via SW2 to either the "CUE BUS" jack, J24, located at the rear of the equipment or to the SIGNAL OUTPUT connector J22, at 600 ohms, +4 dbm.

Simultaneously the signal reproduced from the L track playback head is applied to J10 and the preamplifier and equalizer consisting of Q1 through Q3 of its associated board. General equalization is accomplished in this amplifier but the special de-emphasis network required by this track is external to this amplifier and follows the gain control before the signal is applied to the electronic switch. When the switch selects the "L" track, this fully equalized signal is fed directly to Q5 and so on as described above, to the output terminals.

At the input to the gain control, prior to the special de-emphasis network, the signal from the "L" track is fed via G8 and K3 to the "TRIGGER" board. The function of this unit is to provide at its output terminal K2, either of two direct current potentials, depending on the amplitude of the signal in the "L" track. By way of K2 through the "RANGE" switch SW4 and G6, this is applied to Q4 which controls the current in the indicator neon bulb NE2 and in a neon element in the electronic switch. The electronic switch will be more fully discussed under the description of the "L" PB and SWITCH. The automatic switch can be allowed to operate automatically or held in either the "L" or "H" condition by means of the "RANGE" switch SW4.

CIRCUIT DETAILS

"H" RECORD (1995-305)

Level of input signal applied at A12 is adjusted by R2, with a minimum setting determined by R1. Bias for Q1 is determined by R3 and R4. The signal, after amplification and equalization, is fed by C2 to Q2. Degeneration is provided by R6. High frequency pre-emphasis as required for NAB response is provided by R7, C3 and L1, and C5 with R9 provides low frequency pre-emphasis in accordance with standard accepted practice. Bias for Q2 is obtained from R10 and R11 and the output is applied directly from the collector of Q2 through C7 to terminal A1. R8 provides a discharge path for C7 when K1 is not operated in order to prevent a surge pulse in the record head when this relay operates. R14, R16, C6 and C8 are conventional decoupling networks.

"L" RECORD (1995-303)

The input signal is applied at E12 through C1 to the first amplifier Q1, whose bias is determined by R1 and R2. Degeneration provided by R4 is partially defeated in high frequency portion of spectrum by C6 and R12, resulting in high frequency shelf boost in gain of approximately 7 db at 15 KC with rise from normal occurring at 400 cycles. Signal with this characteristic is applied via R5, C2 and gain control R6, through C3 to Q2, bias for which is determined by R7 and R8. R9 provides degeneration but R11, C4 and L1 provide high frequency pre-emphasis as required for NAB response. In addition, C7 and R13 provide low frequency pre-emphasis in accordance with standard accepted practice. R14 and R15 provide proper bias for Q3. Degeneration in gain of Q3 is provided by R17. This is partially defeated in high frequency portion of spectrum by C10 and R20, resulting in a shelf boost in gain of approximately 8 db at 15 KC with rise from normal occurring at 400 cycles. The output of Q3, which has sufficient power capability to drive the record head, is applied directly from its collector through C8 to terminal E1. R21 provides a discharge path for C8 when K2 is not operated in order to prevent a surge pulse in the record head when this relay operates. R12, R19, C9 and C11 are conventional decoupling networks.

"H" BIAS (1995-301)

The signal from the record board is applied, when the above described relay operates, to terminal B11. It passes through the trap, L1:C5, without attenuation since this is sharply resonant only to the bias frequency and not to audio components. The audio signal then leaves the bias board by terminal B12 unprocessed in any manner except that high frequency bias power is mixed with it.

Bias signal of 250 KC is applied at terminal H of J24 from an oscillator in the tape transport. It feeds through terminal B3 to the input transformer T2. The output of this transformer is applied in push-pull to the power amplifiers Q1 and Q2. The primary of output transformer T1 is tuned to resonate at 250 KC. Bias power from terminal 7 is fed through C4, R6 and R1 to mix with the audio signal. R1 is variable to provide bias amplitude adjustment. Two conductive paths are provided across the secondary of T1. One of these is via CR1 and terminals 3 and 2 of R8 through R9. The other is through R9 and terminals 2 and 1 of R8 through CR2.

The junction of R4, R9 and R8 shows an average DC potential with respect to ground, depending on the setting of the arm of R8. This is zero at the mid-setting of the potentiometer but may be made positive by running the arm toward terminal 3 or negative by running toward terminal 1. This potential causes a small DC current to flow through

the record head via R4. This adjustment is useful in obtaining minimum background noise in the absence of audio signals as it counteracts residual magnetic fields in the recording process.

R2 and R10 provide bias for the transistors. Power is applied to B5 only when the record circuits are activated. C1 is provided to permit the base potentials of the transistors to rise slowly so as to avoid a surge in the record head, which would otherwise cause a click in the tape. Similarly C3 provides a discharge path through R7 to provide relatively slow decay of the bias power when the recorder is taken out of record mode. R11 and C6 provide a decoupling network for all components on the bias board. R5 is provided to permit observation at the test point of the recording head current.

"L" BIAS (1995-301)

This bias board is the same as the one described above except that all references to terminals having "B" designations are changed to "F".

"H" PB AND OUTPUT (1995-306)

There are two distinct parts to this board; the playback preamplifier, employing transistors Q1, Q2 and Q3, and the power output amplifier, consisting of Q4, Q5 and Q6. There is no direct signal connection between the two, the signal from the preamplifier being fed to the electronic switch on another board. The selected signal from said switch is then brought into this unit and applied to the output amplifier.

Signal from the playback head for the "H" track is applied to Q1 through C12 and capacitor C1. Bias for Q1 is provided by R5 from its connection to R6. R22 provides damping for the specific head employed and may have a different value for heads of different design. Q1 is an especially low noise transistor selected to provide maximum signal to noise ratio in the over-all system. Its output is directly coupled to the base of Q2 and a selective feedback circuit is provided consisting of C3 and R2 which achieves a basically flat spectral response from the tape.

As the frequency rises, the gain of this amplifier is reduced by 6 db per octave through most of the spectrum. The high frequency at which this function no longer is followed and at which the response flattens out is determined by the setting of R2. Rx is selected to again flatten out the response below 30 cycles so that the 6 db rise in gain at extremely low frequencies is no longer followed. R4 and C2 constitute a decoupling network for the first stage to assure quietest operation. Because of the direct connection between collector of Q1 and base of Q2, common bias is provided by R6, by-passed by C4. Q3 operates as an emitter follower directly coupled to Q2. This lowers the circuit impedance at the output, feeding through C9 to the "GAIN" control. The output of the gain control is fed out on terminal C7 to the electronic switch.

Signals selected by the electronic switch are applied by terminal C6 through capacitor C5 to Q4. The collector of this transistor is direct coupled to the base of power output transistor Q6 and to the base of Q5. The bases of these transistors are separated by a DC potential determined by the voltage drop occurring across R14 and CR1. The R14 drop is essentially constant but that CR1 varies with temperature in such manner that Q5 and Q6 are operated with proper bias for class AB operation regardless of temperature. C7 is a by-pass for audio signals. The "BALANCE" control adjusts the DC voltage fed back from the junction of Q5 and Q6 to change the bias on Q4. Due to the DC connection of this amplifier, the end result is an adjustment of the DC potential at the junction on Q5 and Q6. This is set to a potential exactly half that of the potential measured across the source of power, C6. Q5 and Q6 constitute a complementary-symmetry push-pull output amplifier which feeds through capacitor C8 to terminal C2. This is connected to the output transformer to feed the output line at 600 ohms. R21 and C10 across the resistor R13 constitute a high frequency rise network to effect a small correction for high frequency loss in the output transformer. R20 is a discharge resistor for capacitor C5 to prevent switching clicks when the monitor switch is operated. R11 and C6 constitute a decoupling network.

"L" PB AND SWITCH (1995-307)

There are two distinct parts to this board; the playback preamplifier, employing transistors Q1, Q2 and Q3, and the electronic switch, consisting of the switch element K1 and transistors Q5 and Q6.

Signal from the playback head for the "L" track is applied to Q1 through G12 and capacitor C1. Bias for Q1 is provided by R5 from its connection to R6. R28 provides damping for the specific head employed and may have a different value for heads of different design. Q1 is an especially low noise transistor selected to provide maximum signal to noise ratio in the over-all system. Its output is directly coupled to the base of Q2 and a selective feedback circuit is provided consisting of C3 and R2 which achieves a basically flat spectrum response from the tape. As the frequency rises, the gain of this amplifier is reduced by 6 db per octave through most of the spectrum. The high frequency at which this function no longer is followed and at which the response flattens out is determined by the setting of R2. Rx is selected to again flatten out the response below 30 cycles so that the 6 db rise in gain at extremely low frequencies is no longer followed. R4 and C2 constitute a decoupling network for the first stage to assure quietest operation. Because of the direct connection between collector of Q1 and base of Q2, common bias is provided by R6, by-passed by C4. Q3 operates as an emitter follower directly coupled to Q2. This lowers the circuit impedance at the output, feeding through C10 to the "GAIN" control. The arm of the gain control feeds a pair of attenuator networks R11, R12, C5, and R24, R25, C6. These attenuate the high frequency portion of the spectrum in a manner inverse to the shelved rise in response built into the "L" record electronics (1995-303) described above. There is no attenuation provided by these networks for frequencies below 400 cycles but 15 KC is attenuated 15 db. The output of these networks is of relatively high impedance (R24 is 100K) and this is fed directly to the base of Q5, an emitter follower coupled directly to Q6, a second emitter follower. The double emitter follower combination matches this high impedance to the relatively low output impedance at C8. R16 and R17 provide proper bias operation for Q5 and Q6. R26 is a discharge resistor for leakage current in C8 to prevent clicks when the Monitor Switch is operated.

The high impedance path between R24 and Q5 through C7 is connected to one of the "signal" terminals of the electronic switch. The other "signal" terminal is connected to the source of signal from the "H" PB and OUTPUT board via terminal G1. When the electronic switch is open, there is no internal connection between these signal terminals and consequently the "L" track signal is passed directly from R24 to Q5. When the switch is closed, its two signal terminals are connected together. The signal coming in from the "H" track via G1 is from a low impedance source and this is now fed directly through the switch and C7 to the base of Q5. Because this is from a low impedance source, it effectively short circuits the high impedance source from the "L" track. The result is that at any time either the "L" or the "H" track furnish signal to the output of this board at G10.

The electronic switch is really a unit consisting of a photo-resistor mounted in a light-tight box with a neon lamp. When the lamp is not lit, the resistor has a very high internal resistance, (tens of megohms). When the lamp is illuminated, the resistance drops to a few hundred ohms. The time required for the resistance to drop to a stable low value is about 200 microseconds but when the lamp is extinguished, the resistance rises to its maximum value in about 15 milliseconds. During transitions, the signal is effectively cross-faded from one source to the other and since no direct current components are involved in the switching process, there are no resultant clicks or thumps.

The internal neon lamp is connected to the control terminals. It is turned off and on by either a conductive or nonconductive state of transistor Q4. The emitter of Q4 is held at about plus 14 volts applied at G7. A two-state control potential appears at G6 and either renders Q4 conductive or cut off. When Q4 is cut off, its collector rises until the lead connected to G2 finds 91 volts through terminal J1 of the "L" POWER supply (1995-304). G3 is supplied with 130 volts. The control terminals of the switch therefore are supplied with a potential of 130 minus 91, or 39 volts through R14, which is insufficient to sustain lamp glow. This voltage is high enough, however, to light the neon track monitor indicator lamp connected to G2. When Q4 is rendered conductive, the collector drops to about 16 volts above ground. Through R14, the lamp in the switch then sees sufficient applied voltage to

cause it to light (130 minus 16, or 84 volts). At the same time, the voltage across the track monitor lamp is reduced to 16 volts which causes it to be extinguished. Therefore, when the "L" track feeds the output circuits the switch lamp is extinguished but the monitor lamp is lit. When the "H" track feeds the output circuits, the switch lamp is lit and the monitor lamp is out. The function of the "RANGE" switch will be dealt with in the description of the "TRIGGER" board below.

TRIGGER (1995-300)

This circuit is provided for one specific function: to decide when the audio signal being reproduced from the "L" track has reached a distortion level where switching should occur and thereby activate the electronic switch, and inversely to return the output to the "L" track after such distortion level has passed. It does this as follows: A tap is taken from the signal reproduced from the "L" track ahead of its gain control. This is fed out on terminal G8 to the input K3 of the TRIGGER board. The "GAIN" pot determines the size of signal fed to the amplifier Q1 via C1 which is chosen to act with R2 to attenuate frequencies below about 400 cycles. This signal, with attenuated low frequencies, is fed through C2 and R6 to Q2. Q2 and Q3 are connected together in a trigger circuit. In the absence of input signals, R7 holds the base of Q2 sufficiently positive to keep Q2 heavily conductive. This pulls down the potential at the junction of R8 and R9 and raises the potential of the emitters of both Q2 and Q3. The result of this, aided by the voltage drop at the base of Q3 caused by R11, is that Q3 is completely cut off. Audio signals amplified by Q1 try to change the potential at the base of Q2, but if smaller than a certain specific negative going value, they do not cause a reduction in current in Q2. When this critical value is reached, however, the collector potential begins to rise and this causes a rise of base potential at Q3, bringing Q3 into conduction. Because R12 is of lower value than R8, Q3 actually draws more current than did Q2. Because of R10, the emitter of Q2 rises, further cutting off Q2 as its base potential continues to drop or even to remain constant. The end result, which takes place in a matter of a very few microseconds is that Q2 is completely cut off and Q3 is fully turned on. This condition remains unchanged until the instantaneous signal voltage falls below a certain specific value, somewhat less than that which caused triggering. At such time, the base potential of Q2 is raised sufficiently to bring Q2 into conduction and an inverse process to the one described above occurs, causing Q3 to be quickly cut off.

It will be seen that for any signal level exceeding the trigger potential Q2 and Q3 will function to generate a rectangular output waveform for each cycle of such excessively large wave. Thus, if the signal is a 15 KC tone of high amplitude, the trigger will generate a 15 KC rectangular wave. This is not directly useful to operate the electronic switch control lamp. It is necessary to light the lamp the instant triggering signal level is exceeded, but to keep the lamp lit at least long enough for the succeeding cycle of audio, at the lowest possible frequency of interest, to be checked for amplitude and this process must be continued until the level has dropped below the unacceptable value. The lowest frequency of interest in this respect is 400 cycles. Therefore, the lamp must be kept lit for a minimum of 2.5 milliseconds after it has been turned on.

To accomplish this holding time, a simple time constant is employed in conjunction with a second trigger circuit.

When the first trigger (Q2 and Q3) is in its normal rest condition, the collector of Q3 is at a high (bus) potential. Through R13, this causes Q4 to be cut off. C3 is uncharged and R15, being at a low potential assures that Q5 is nonconductive. Q5 and Q6 operate exactly as previously described for Q2 and Q3. Therefore, Q6 is heavily conductive.

When distortion level is exceeded and Q3 is brought into conduction, Q4 is brought into conduction and its collector rises instantly, the initial step in voltage being permitted by R14 until C3 can charge. The step occurring at the collector of Q4, triggers Q5 and Q6 and the change in potential at terminal K2 causes the lamp to light in the switch. All this occurs within a very few microseconds. When Q4 is cut off by the first trigger, however, C3 maintains the collector potential high enough for a sufficiently long enough time before it releases Q5 to assure that a second cycle of 400 cycle signal has been checked. (As stated above, this is approximately 2.5 milliseconds). R16 and C4 constitute a decoupling network for the power supply.

Observe that the path between terminals K2 and G6 passes through the "RANGE" switch SW4. In its mid position, "AUTO", a direct connection is provided so that the trigger circuit can cause automatic track switching as needed. In the "LO" position the switch remains locked in the "L" track position since terminal G6 is held to a ground path through R1. In the "HI" position, G6 is held to a high voltage path through R2.

The "GAIN" control on the TRIGGER board is adjusted so that triggering occurs when the signal level in the "L" track reaches an amplitude representative of 1% or 2% total harmonic distortion. The setting is not particularly critical.

"H" POWER SUPPLY (1995-302)

This board and its external power transformer T3 and transistor Q2A constitute a regulated DC power supply furnishing plus 18 volts with very low ripple content. AC power is applied at D6 and D7. A full wave bridge consisting of CR1, CR2, CR3 and CR4 converts this to direct current. The main load is taken through surge resistor R1 and anti-parasitic choke L1 to the collector of Q2A via terminal D8. C1 is the main energy storage capacitor. The pulsating DC from the rectifier bridge is also fed through CR5 and protective resistor R2 to filter capacitor C2. R3 and C3 provide additional DC filtering. The current through R4 can be caused to vary with change in potential of the base of Q1. This causes a change in the potential of the base of Q2A due to its direct connection via D10 to the collector of Q1. Any change in the base potential of Q2A causes the output voltage appearing at its emitter to be altered, but this is fed back through D5 to R7, the "VOLTAGE" control, to adjust the base potential of Q1. This feedback with the relatively high gain of Q1 results in extremely stable output voltage which may be adjusted, however, by R7 to its operating value of plus 18 volts.

The emitter of Q1 must be maintained at a fixed reference potential and this is accomplished by CR6, a Zener diode which holds a constant voltage drop. The regulator functions for all normal loads over an input line voltage range of 95 to 135 AC volts.

"L" POWER SUPPLY (1995-304)

This board and its external power transformer T4 and transistor Q2B constitute two regulated DC power supplies. One of them furnishes plus 130 and plus 91 volts direct current and the other furnishes plus 26 volts with very low ripple content. High voltage AC power is applied at J11 and J12. A full wave bridge consisting of CR1, CR2, CR3 and CR4 converts this to direct current. Surge resistor R1 applies this to storage capacitor C1. Current flows through R2 to supply the external load and series Zener diodes CR11 and CR10. Zener diode CR10 maintains a constant voltage of 91 volts across its terminals and Zener diode CR11 maintains 39 volts. J3 is thus held at 91 volts and J6 at 130 volts. These voltages remain constant for all normal load variations occasioned by operation of the electronic switch and over input line variations from 95 to 135 AC volts. CR13 functions to prevent the potential at J1 from exceeding 91 volts, but permits the voltage to drop without restriction to lower values as demanded by the electronic switching circuits.

CR5, CR6, CR7 and CR8 constitute another full wave bridge getting power from a low voltage winding of T4 via J9 and J10. The main rectified load is taken through surge resistor R3 and anti-parasitic choke L1 to the collector of Q2B via terminal J8. C3 is the main energy storage capacitor. The pulsating DC from the rectifier bridge is also fed through CR9 and protective resistor R4 to filter capacitor C2. R9 and C5 provide additional DC filtering. The current through R5 can be caused to vary with change in potential of the base of Q1. This causes a change in the potential of the base of Q2B due to its direct connection via J5 to the collector of Q1. Any change in the base potential of Q2B causes the output voltage appearing at its emitter to be altered, but this is fed back through J7 to R7, the "VOLTAGE" control, to adjust the base potential of Q1. This feedback with the relatively high gain of Q1 results in extremely stable output voltage which may be adjusted, however, by R7 to its operating value of plus 26 volts.

The emitter of Q1 must be maintained at a constant fixed reference potential and this is accomplished by CR12, a Zener diode which holds a constant voltage drop. C4 provides some phase advance in the system to stabilize the feedback. This regulator functions for all normal loads over an input line voltage range of 95 to 135 AC volts.

CIRCUIT DESCRIPTION: TRANSPORT WIRING

Reference Drawing Number 1995-320

GENERAL

The above referenced drawing is a schematic of the complete wiring to be found in the tape transport, with the exception of the record and playback head wiring. Complete and essentially self-explanatory information on the wiring of heads is shown on the "Interchassis Signal Cabling" drawing. The transport schematic applies to recorders of any number of channels.

The transport is novel in a number of ways. No mechanical brakes are employed. Tape is stopped by applying full winding power to the reel from which tape has been unwinding. Power is automatically cut off when the tape reaches standstill. Direct current motors are employed for the supply and take-up reeling functions. A completely interlocked relay system permits any mode of operation to be selected directly while any other is in effect. Thus, it is possible to select "PLAY" while in the "FAST FORWARD" or "REWIND" modes without damaging tape. Facilities for automatic rewind and for starting a second machine are provided at the end of a reel. An automatic playback shield door is provided which opens in fast forward or, to facilitate editing, when tape is manually lifted from its normal path.

An examination of Transport Schematic 1995-320 shows that all electrical components are divided into two groups; those mounted in one location or another directly on the tape transport mechanism, and those within the dotted area which are mounted on the printed control circuit board. Each small square containing a number or letter represents an equivalently numbered terminal on the printed board. The small ovals containing numbers represent the terminal strip behind the printed board to which are connected the leads from the capstan motor and its capacitor and the leads from the two torque motors.

POWER "ON"

A standard three-wire power cable is provided which must be connected at J1. The third or ground lead must be connected to a good system ground, otherwise the entire recorder will not meet dynamic range specifications due to hum, harmonic buzz or radio frequency fields. The power is normally 60 cycles, 105 to 135 volts, but 50 cycle models for the same voltage range entail only a change of capstan motor specifications. The schematic remains otherwise unchanged.

The power switch SW-1, when operated, closes both sides of the line activating a number of circuits. These are as follows:

1. The only circuit activated on the printed board itself is the bridge rectifier CR5, CR6, CR7, CR8, which charges C2 through R17 to approximately 165 volts DC in the absence of load. This voltage is applied via 76 and 80 to the fields of the rewind and take-up motors. The field returns are via 77 and 81 through K1 (10,6) (9,5), as this relay will operate as soon as power is turned on unless the transport has been previously threaded with tape.
2. Power is applied to the capstan motor from terminals 54 and 25 on one side of the line and 48, 49 and 60 on the other side of the line to the capstan motor and its two-position speed control switch SW-8.
3. Power is supplied from terminals A and D to equivalently lettered terminals on the "Electronics Power" connector, J2.
4. Power is supplied to a step-down transformer T-1 from terminals 87 and 88. The low voltage secondary feeds terminals 89 and 90. A full wave bridge on the board consisting of CR1, CR2, CR3, CR4 supplies charging current through terminals 21 and 22 to C-1 and regulator transistor Q2. A Zener diode CR18 is fed from R10 and establishes a reference voltage of 27 volts, applied through R11 to the base of amplifier transistor Q1. The collector of Q1 is direct coupled to the base of Q2 and the output collector potential of Q2 establishes the base potential of Q1. The two transistors thus act to regulate the bus potential (terminal 85) to keep it at 26.5 volts. Whenever the power is turned on, this bus potential lights the "POWER"

indicator lamp LP-1 via 46 and 47 and the tape sensing lamp LP-8 via 31 and 35.

Transformer T-1 also feeds diodes CR9 and CR10 but it will be observed that there is no filter network on the output of these diodes. A full wave rectified voltage waveform appears at their output which should instantaneously attain zero voltage twice per cycle of the applied power. It is necessary for zero voltage to occur in this manner for proper functioning of the equipment connected to this source of power, but it is possible because of stray capacitance that zero may not occur. Therefore, two more diodes are connected in series with this source. These are CR28 and CR12. Because of their contact potential characteristics, the output of each will always be about a volt closer to zero than their input. Thus the output of CR12 will rest at zero volts for an interval given by the time the output of CR9 or CR10 has fallen below 2 volts until it has again risen to 2 volts. This is sufficient time for the connected circuits to operate properly.

One of these circuits is the light switch PQ-3 (out) connected to 34. With voltage applied across 1 and 2 of its terminals, no current will flow as long as it is dark. In the absence of tape on the machine, a light path is established from lamp LP-8 to PQ-3 rendering it conductive and operating K-1 through 30. The nature of PQ-3 is such that having been rendered conductive by light, it will remain conductive even though the source of light is removed, so long as a source of current is supplied. In order to turn off the device, the source of current and the source of light must both be removed. Hence, the need for periods of zero voltage, assured twice per cycle of the 60 cycle supply by CR28 and CR12.

With K-1 operated because no tape is threaded on the machine, contacts K-1 (12,8) are closed, supplying voltage via 1 to "L" of the Remote Control connector to light a lamp showing the machine is on but not threaded. Also, through CR30 and 41 the playback shield cover door is caused to open by means of the door solenoid, with a return path via 43. Contacts K-1 (12,4) are open and the 26.5 volt bus can perform no further function. Because of this, the machine may not be put into any mode of operation until tape is threaded in place.

THREAD TAPE

When a reel of tape is placed on the supply spindle, the free end is laced through the in-going side of the capstan, around the reversing idler and between the outgoing side of the capstan and its pressure roller. When tape is dropped into position at this point, the light is cut off PQ-3 and when its applied voltage reaches its first zero, it becomes nonconductive, remaining in this state until tape is removed. Removal of current from 30 drops out K-1. CR11 is a surge protective diode. When K-1 (12,8) is broken, the head shield cover is closed because the door solenoid is released and the Remote thread lamp is extinguished. Closure of K-1 (12,4) applies bus potential through K-5 (11,3), K-4 (11,3), K-6 (11,3) and K-3 (12,4) via 6 to light the "STOP" lamp LP-4 and a path through CR40 and R15 charges C-8 and operates K-2. Several other paths are likewise made ready. The opening of K-1 (10,6) (9,5) inserts R4 in the return path of the torque motor fields, and the voltage developed across this resistor is applied via K-3 (1,9), K-4 (1,9), and K-5 (1,9) via 78 to the armature of the rewind motor. A similar path applies the same voltage to the take-up motor via K-3 (2,10), K-4 (2,10), K-5 (2,10) and 74. The torque so generated is very small; sufficient to remove slack threaded tape but not enough to cause motion of the tape from a large diameter reel to a smaller one.

With the end of the tape threaded into the take-up hub, the transport is ready to be put into motion from its stand-by condition.

"PLAY" MODE FROM STANDSTILL

Bus potential stands, via 14 on SW-2 (2). Closure of the momentary contact push button "PLAY" switch applies this via 4 through CR13 to operate K-8 momentarily. Via K-5 (11,3), K-4 (11,3), K-6 (11,3) and K-8 (8,12) K-3 is caused to operate. Release of the operating button releases K-8 but K-3 remains locked up via K-3 (8,12), K-6 (3,11) etc. The "PLAY" lamp LP-2 remains lit via 8 since it is in parallel with the coil of K-3. This same supply immediately operates the in-going capstan pressure roller solenoid via 68, clamping the tape gently, under control of a dash pot, to the constant speed capstan. The break at K-3 (12,4)

removes bus voltage from C-8 and the coil of K-2 so that after about .3 of a second K-2 releases. The closure of K-2 (11,3) applies bus to 66 and operates the outgoing pressure roller idler. This occurs after the tape has had time to be accelerated to running speed under control of the ingoing solenoid.

When K-3 operates, the transfer of K-3 (2,10) to (6,10) applies full DC power via K-2 (6,10), K-3 (6,10), K-4 (2,10) and K-5 (2,10) to the take-up motor armature, and a reasonably high hold-back torque to the supply motor via K-2 (6,10), R1, K-3 (5,9), K-4 (1,9) and K-5 (1,9). After the tape is up to speed and K-2 has released, the break at K-2 (6,10) inserts resistors R16 and R18 in the armature paths to establish proper winding and holdback torques since acceleration conditions are replaced by constant velocity operation.

"STOP" FROM "PLAY"

Whenever tape is moving in the forward direction, the lamp LP-7 is permitted to shine directly on the light switch PQ-I,'but it is shielded by a drag mask from illuminating PQ-2. Whenever the tape is moving in the reverse direction, the drag mask moves to a different position, permitting light to fall on PQ-2 and to shield the light from PQ-1.

With the tape operating in the play mode, if the "STOP" button SW-4 is pressed, the following takes place.

Bus voltage is applied from K-8 (10,2) terminal 12, SW-4 (2,4) terminal 9 to operate K-6. From the pulsating power supply through terminal 20, PQ-1, being illuminated, supplies current through terminal 17, K-6 (6,10) to operate K-5. K-5 closes a holding path for K-6 via K-5 (12,8), K-6 (8,12) to K-6 (14), so that K5 and K6 both remain operated after pressure is removed from SW-4. The "RWD" lamp is lit via K-5 (11,7).

The break occurring at K-6 (3,11) opens the holding circuit for K-3 and it releases, extinguishing the "PLAY" lamp, and dropping out the capstan pressure roller solenoids so as to unclamp the tape from the driving capstan. The operation of K-5 provides full torque power via K-5 (5,9) through 78 to the Rewind motor, while the break at K-5 (2,10) removes all take-up motor torque, bringing the tape to standstill and attempting to start it in the reverse direction. The slightest motion of the tape in the opposite direction, however, causes the drag mask to cover PQ-1, allowing the light switch to open the holding path for K-5. K-5 drops out and standby holding torque is applied to the tape. The release of K-5 opens the holding path of K-6 via K-5 (12,8), K-6 (8,12). K-6 releases but operates K-2 via K-5 (11,3), K-4 (11,3), K-6 (11,3), K-3 (12,4), CR40 and R15. With the exception of K-2, all relays are normal and the "STOP" lamp is lit.

"RWD" FROM "STOP"

With the tape in standby, pressure of the "RWD" button SW-5 causes bus voltage to be applied through K-8 (10,2), 12, SW-5 (2,4), 7, K-6 (2,10) to operate K-5.

K-5 applies rewinding torque via K-5 (5,9) as outlined above and K-5 locks up to bus via K-5 (11,7), K-6 (2,10). The tape accelerates in the rewind direction with full power on the armature of the rewind motor. Since this is a DC shunt motor, it would reach a certain terminal velocity at which time tape would be loosely wound except for the following feature. As the tape comes up to speed in rewind, the armature of the take-up motor is open circuited due to the break at K-5 (2,10). It is operated as a DC generator without load until a definite terminal voltage is reached, the voltage rising as its speed goes up. CR21 is a Zener diode which will not pass current until 75 volts are applied across its terminals. Therefore when the generated voltage reaches or tries to exceed this value, current flows via 75, CR19, CR21 and 74 to act as a load and effective brake on the take-up motor, limiting the maximum speed at which it will supply tape and thereby providing a controlled winding tension in the reel being filled.

Closure of K-5 (12,8) provides a path through CR31 to open the playback cover door and through 36 and 38 to operate the tape lifters.

"RWD" TO "STOP" (Tape moving in Rewind direction)

Pressure of the stop switch SW-4 operates K-6 via K-8 (10,2), 12, SW-4 (2,4) and 9. Since tape is moving in the rewind direction the drag switch permits light to fall on PQ-2 while PQ-1 is masked. Therefore through 20, PQ-2, 18, and K-6 (5,9), K-4 is caused to operate. K-6 is locked up via K-4 (12,8), K-6 (8,12), and K-4 is therefore held up by PQ-2. K-5, however, is released by the break occurring at K-6 (10,2) and the fact that PQ-1 is dark and therefore not conductive.

The power that was supplied to the rewind motor via K-5 (5,9) is removed by its release and transferred via operation of K-4 through K-4 (6,10) to the take-up motor which now pulls to bring the tape to standstill and attempts to reverse it to the forward direction. As soon as the drag mask covers PQ-2, K-4 releases, returning all circuits to the standby condition.

During the stopping interval the "RWD" lamp is extinguished and the "FWD" lamp is lit due to release of K-5 and operation of K-4. In standby, the door and lifter solenoids are released and K-6 is released by the break at K-4 (8,12).

"RWD" TO "STOP" (Tape moving in Forward direction)

It is possible while shuttling tape at high speed to have the tape moving in the forward direction but to have the controls in the rewind mode. If the "STOP" button is pressed at this time, K-6 is picked up in the manner described above. K-5 is not released, however, in favor of K-4 because PQ-2 is masked while PQ-1 is illuminated. Thus K-5 remains operated and the tape comes to standstill and attempts to reverse at which time PQ-1 is masked, releasing K-5 and putting the mechanism in standby. At this time, the door and lifter solenoids are released and K-6 is released by the break at K-5 (8,12).

"FWD" FROM "STOP"

With tape in standby, pressure of the "FWD" button SW-3 causes bus voltage to be applied through K-8 (10,2), 12, SW-4 (1,3), SW-5 (3,1), SW-3 (2,4), 10, CR-14, K-6 (1,9) to operate K-4.

K-4 applies full torque to the take-up motor via K-4 (6,10), K-5 (2,10) and 74 causing tape to accelerate in the forward direction. K-4 locks up to bus via K-6 (9,1), K-4 (7,11) and K-5 (3,11). Since the take-up motor is a DC shunt type, it would reach a certain terminal velocity at which time tape would be loosely wound except for the following feature. As the tape comes up to speed in the forward direction, the armature of the rewind motor is open circuited due to the break at K-4 (1,9). It is operated as a DC generator without load until a definite terminal voltage is reached, the voltage rising as its speed goes up. CR-22 is a Zener diode which will not pass current until 75 volts are applied across its terminals. Therefore, when the generated voltage reaches or tries to exceed this value, current flows via 79, CR-20, CR-22 and 78 to act as a load and effective brake on the rewind motor, limiting the maximum speed at which it will supply tape and thereby providing a controlled winding tension in the reel being filled.

Closure of K-4 (12,8) provides a path through CR-31 to open the playback cover door and through 36 and 38 to operate the tape lifters.

"FWD" TO "STOP" (Tape moving in Forward direction)

Pressure of the Stop switch SW-4 operates K-6 via K-8 (10,2), 12, SW-4 (2,4) and 9. Since tape is moving in the forward direction, the drag switch permits light to fall on PQ-1 while PQ-2 is masked. Thus via 20, PQ-1, 17, and K-6 (6,10), K-5 is caused to operate. K-6 is locked up via K-5 (12,8), K-6 (8,12), and K-5 is therefore held up by PQ-1. K-4, however, is released by the break occurring at K-6 (9,1) and the fact that PQ-2 is dark and therefore not conductive.

The power that was supplied to the take-up motor via K-4 (6,10) is removed by its release and transferred via closure of K-5 (5,9) to the rewind motor which now pulls to bring the tape to standstill and attempts to reverse it to the rewind direction. As soon as the drag mask covers PQ-1, K-5 releases, returning all circuits to the standby condition.

During the stopping interval, the "FWD" lamp is extinguished and the "RWD" lamp is lit due to release of K-4 and operation of K-5. In standby, the door and lifter solenoids are released. K-6 is released by K-5 (8,12).

"FWD" TO "STOP" (Tape moving in Rewind direction)

It is possible, while shuttling tape at high speed, to have the tape moving in the rewind direction but to have the controls in the forward mode. If the "STOP" button is pressed at this time, K-6 pulls in in the manner described above. K-4 is not released, however, in favor of K-5 because PQ-1 is masked while PQ-2 is illuminated. Thus K-4 remains operated and the tape comes to standstill and attempts to reverse at which time PQ-2 is masked, releasing K-4 and putting the mechanism in standby. At this time, the door and lifter solenoids are released, and K-6 is released by the break at K-4 (8,12).

"RWD" FROM "FWD"

Considering tape to be in the Forward mode regardless of its actual direction of motion, relay K-4 is the only relay off normal. Pressure of the "RWD" button closes a circuit to operate K-5 via K-8 (10,2) SW-5 (2,4), 7 and K-6 (2,10). K-5 (11,3) opens, removing the holding path for K-4 via K-4 (11,7). Thus K-4 releases when K-5 operates, thereby reversing the torque to the motors via respective relay contacts K-4 (6,10) and K-5 (5,9). K-5 locks up via K-5 (11,7), K-6 (2,10).

"FWD" FROM "RWD"

Considering tape to be in the Rewind mode regardless of its actual direction of motion, relay K-5 is the only relay off normal.

Pressure of the "FWD" button closes a circuit to operate K-4 via K-8 (10,2), 12, SW-4 (1,3), SW-5 (3,1), SW-3 (2,4), 10, CR-14 and K-6 (1,9). Terminal 14 of K-5 has been connected to bus potential and pressure of SW-3 applies bus potential via 10 and CR-15 to R-2. Since the same voltage is thereby effectively connected to both sides of the coil of K-5, it releases and the torque is thereby removed from the rewind motor since K-5 (5,9) is opened, and it is applied to the take-up motor via K-4 (6,10). K-4 locks up via K-5 (11,3), K-4 (11,7) and K-6 (1,9).

"PLAY" FROM "RWD"

In the Rewind mode, regardless of actual direction of tape motion, only relay K-5 is operated. Momentary pressure of the play button SW-2 causes bus power to flow through 14, SW-2 (2,4), 4 and CR-13 to operate K-8. Via K-5 (12,8), K-8 (9,5) R12, C-35 and C-34 a locking path is established for K-8 to hold it after the button is released. K-8 (10,2) opens the paths to SW-3, SW-4 and SW-5 buttons to render them inactive at this time. The potential from K-5 (12,8) through K-8 (9,5) and R-12 also feeds through CR-36 to terminal 14 of K-6 causing it to operate. Because this opens the holding path of K-5 via K-6 (10,2) and K-5 (7,11) a vibrating condition could arise but this is prevented by the charge in C-6 which continues to hold K-6 until the transfer of K-5 is effected if it need be. Whether K-5 continues to hold or to transfer to K-4 is determined by the direction the tape is moving as outlined in sections above. In any event, operation of K-6 functions to bring tape to a standby condition. When K-4 or K-5 are released by the light switch mask as the tape reaches standstill and attempts to reverse, the break occurring at K-4 (8,12) or K-5 (8,12) releases K-6. Normally, the machine would remain in standby, but at this time K-8 is still operated even though its supply path via K-8 (9,5) is dead. This is because it is held by the charge in C-7 for a sufficient time to perform an additional function. When K-6 releases, bus is supplied via K-5 (11,3), K-4 (11,3), K-6 (11,3) and K-8 (8,12) to operate K-3. The functions from here on are as described under "PLAY MODE FROM STANDSTILL".

"PLAY" FROM "FWD"

In the forward (high speed) mode, regardless of actual direction of tape motion, only relay K-4 is operated. Momentary pressure of the play button SW-2 causes bus power to flow through 14, SW-2 (2,4), 4 and CR-13 to operate K-8. Via K-4 (12,8), K-8 (9,5) R12, C-35 and C-34 a locking path is established for K-8 to hold it after the button is released. K-8 (10,2) opens the paths to SW-3, SW-4 and SW-5 buttons to render them inactive at this time. The potential from K-4 (12,8) through K-8 (9,5) and R-12 also feeds through CR-36 to terminal 14 of K-6 causing it to operate. Because this opens the holding path of K-4 via K-6 (9,1) and K-4 (7,11) a vibrating condition could arise but is prevented by the charge in C-6 which continues to hold K-6 until the transfer of K-4 is effected, if it need be. Whether K-4 continues to hold or transfer to K-5 is determined by the direction the tape is moving as outlined in sections above. In any event, operation of K-6 functions to bring tape to a standby condition. When K-4 or K-5 are released by the light switch mask as the tape reaches standstill and attempts to reverse, the break occurring at K-4 (8,12) or K-5 (8,12) releases K-6. Normally, the machine would remain in standby, but at this time K-8 is still operated even though its supply path via K-8 (9,5) is dead. This is because it is held by the charge in C-7 for a sufficient time to perform an additional function. When K-6 releases, bus is supplied via K-5 (11,3), K-4 (11,3), K-6 (11,3) and K-8 (8,12) to operate K-3. The functions from here on are as described under "PLAY" MODE FROM STANDSTILL".

TAPE RUNOUT

When the tape runs out from any mode of operation, the light from lamp LP-8 falls on PQ-3 causing it to conduct and operate K-1. This opens the bus supply to all other relays regardless of which is held operated at the time. All power is therefore removed from the armatures of the take-up or rewind motors. A short circuit is applied to the armature of each motor. One such path is from 75 through K-1 (5,9) (6,10), K-3 (2,10), K-4 (2,10), K-5 (2,10) and 74. The other is from 79 through K-1 (5,9) (6,10), K-3 (1,9), K-4 (1,9), K-5 (1,9) and 78. Since the fields are still fully excited, this system acts to brake the motors to standstill since they operate as DC generators operating into a short circuit.

"RECORD" MODE

The Record mode can only be selected when the "PLAY" lamp is lit, indicating that the machine is running at normal speed. It is then necessary to simultaneously press both the "RECORD" button SW-6 and the "PLAY" button SW-2.

Bus is applied through 14, SW-2 (2,4), SW-6 (2,4), 5 and K-3 (7,11) to operate K-7 which then locks up to the holding path for K-3. This is K-3 (8,12), K-7 (8,12). The path established to hold K-7 then lights LP-6 via 11 and feeds the Electronics power connector J-2 on terminal B. It also feeds the master bias oscillator board through CR-43 and R-27 with C-16 provided both for decoupling and for delayed decay after power is removed. Q-3 and Q-4 operate as a simple low power push-pull oscillator providing high frequency signal to terminals E and H. The external cable connected to these terminals carries the signal to all bias boards in the electronics. C-13 is a variable tuning capacitor adjusted to tune the oscillator to 250 KC, when feeding all bias boards in the recorder.

END OF REEL SENSING

Special features are provided under control of the "RUNOUT" switch SW-7. This has three positions. In the mid position, the special features are inactive. The function of PQ-3 has been described. This light switch is located on the outgoing side of the capstan where it can be illuminated after the tape has completely run through the machine at normal speed. Another unit PQ-4 is located on the ingoing side and arranged to scan the tape at a different height from that of PQ-3. PQ-3 scans the lower 1/4 inch of a 1/2 or 3/4 inch tape. PQ-4 scans the upper 1/4 inch of a 1/2 inch or the middle 1/4 inch of a 3/4 inch tape. If a hole is punched, or oxide cleared by washing a small spot of the tape in solvent in the scanning region of PQ-4, but a few feet from the end of the tape, then the special feature will be made operational when light shines through the optical hole if SW-7 is in either end position.

With SW-7 in the "RWD" position, conductivity of PQ-4 furnishes a momentary burst of current through 32, 29, SW-7 and 28 to operate K-5 causing the machine to assume the rewind mode, completely rewinding the tape and shutting off after tape runs

out due to exposure of PQ-3. The source of this burst of power for PQ-4 is via 33 from C-3 which is charged by CR-26, R-14 when the machine is in normal running mode or CR-39, R-3 when it is in the preset mode, awaiting deceleration to standstill prior to automatically going into the play mode.

PQ-4 also supplies momentary power through CR-27 to terminal 13. The lead shown as "Y" may be externally connected to the lead designated as "P" on a second machine. Then when PQ-4 is exposed it will cause the second machine to start in normal play mode.

With the RUNOUT switch SW-7 in the "STOP" position PQ-4 supplies power via 32, 29 and 27 to K-6 to cause it to operate, stopping the tape before it runs out. Again, a second machine can be started automatically as outlined above.

OTHER FEATURES

The speed change switch "SPEED", SW-8, selects windings of the capstan motor to provide either of two speeds. These are related by the ratio 2:1 and can therefore be provided for tape speeds of 30 and 15 inches per second or 15 and 7-1/2 inches per second. Note that connections are shown for two motors, since different manufacturers provide different wiring arrangements.

The reel size switch, "LARGE REEL", SW-9, provides for adjustment of torque in fast forward or in rewind when one spindle carries the normal large reel and the other carries a seven inch or other light weight reel.

If the small reel is on the supply spindle, the switch is moved toward the take-up reel. Operation is normal when the transport is in the Fast Forward mode but when in Rewind mode the voltage generated by the take-up motor feeds through 74, K-5 (10,6), R-6, 93, SW-9, 91, CR-17, 70, R-17, 71 and 75 to provide a slight holdback torque, in order to assure that the smaller reel will be wound with sufficient tension.

If the smaller reel is on the take-up spindle, the switch is operated to the extreme left position where the identical function as described above is provided, R-5 being substituted for R-6, and the additional hold-back applying to the rewind motor rather than the take-up motor.

PERFORMANCE RECORD

FOR

3M PROFESSIONAL MASTERING RECORDER

Serial No.: _____

Adjusted for and tested with 3M tape type: _____
Lot No.: _____

Speed at which tests were made, IPS: _____

Flutter: RMS %, Total, 0.5 to 5000 cycles: _____
0.5 to 30 cycles: _____
30 to 300 cycles: _____
300 to 5000 cycles: _____

Number of channels: _____

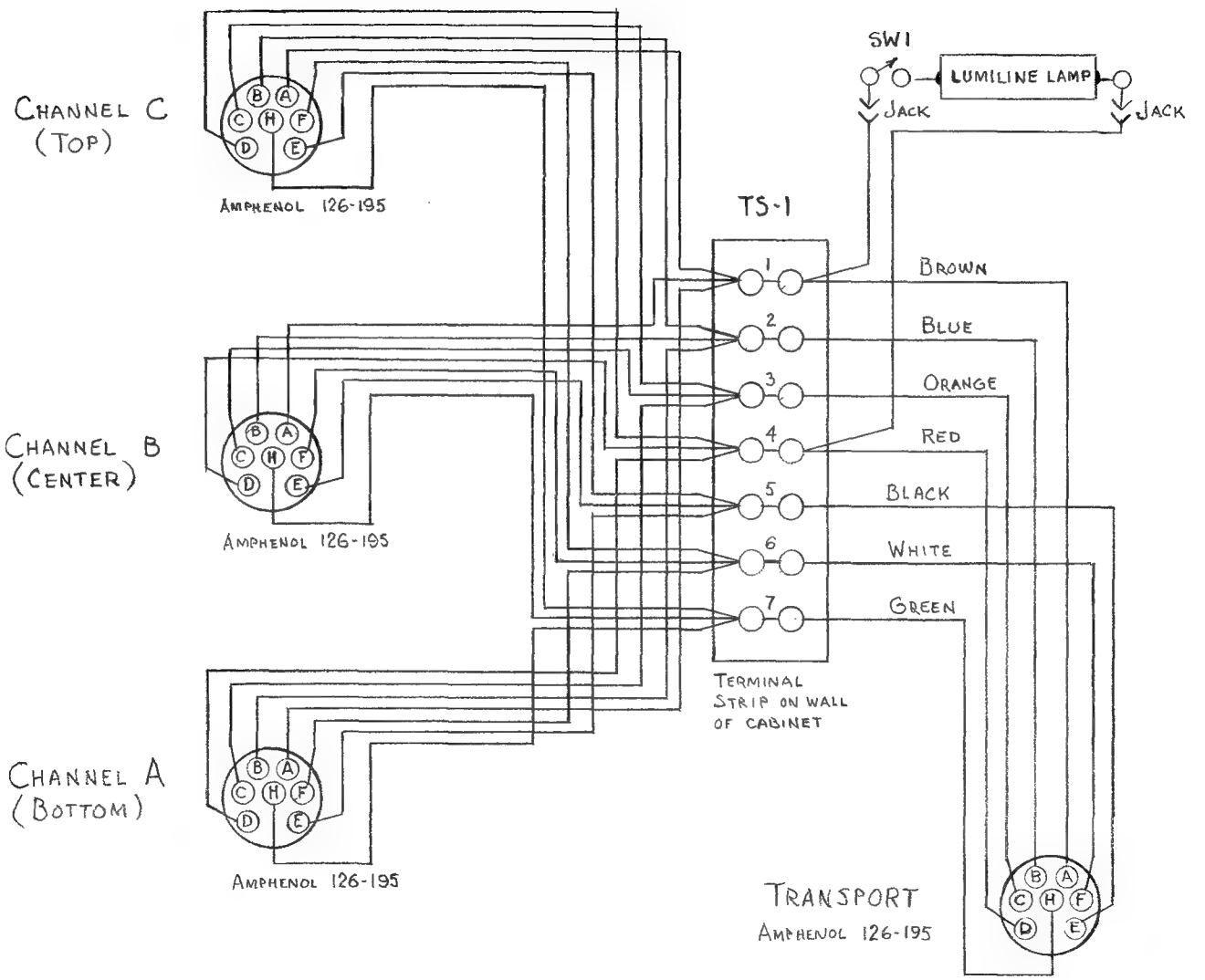
Mounting provided: Cabinet _____ Rack _____ Portable _____

	FREQUENCY RESPONSE: 30 to 15,000 cycles in DB		OUTPUT LEVEL at 3% THD for 400 cycles	DYNAMIC RANGE: 3% THD to ASA weighted noise in DB
Channel 1	Zero VU	-15 VU		
HI track				
LO track				
Channel 2				
HI track				
LO track				
Channel 3				
HI track				
LO track				

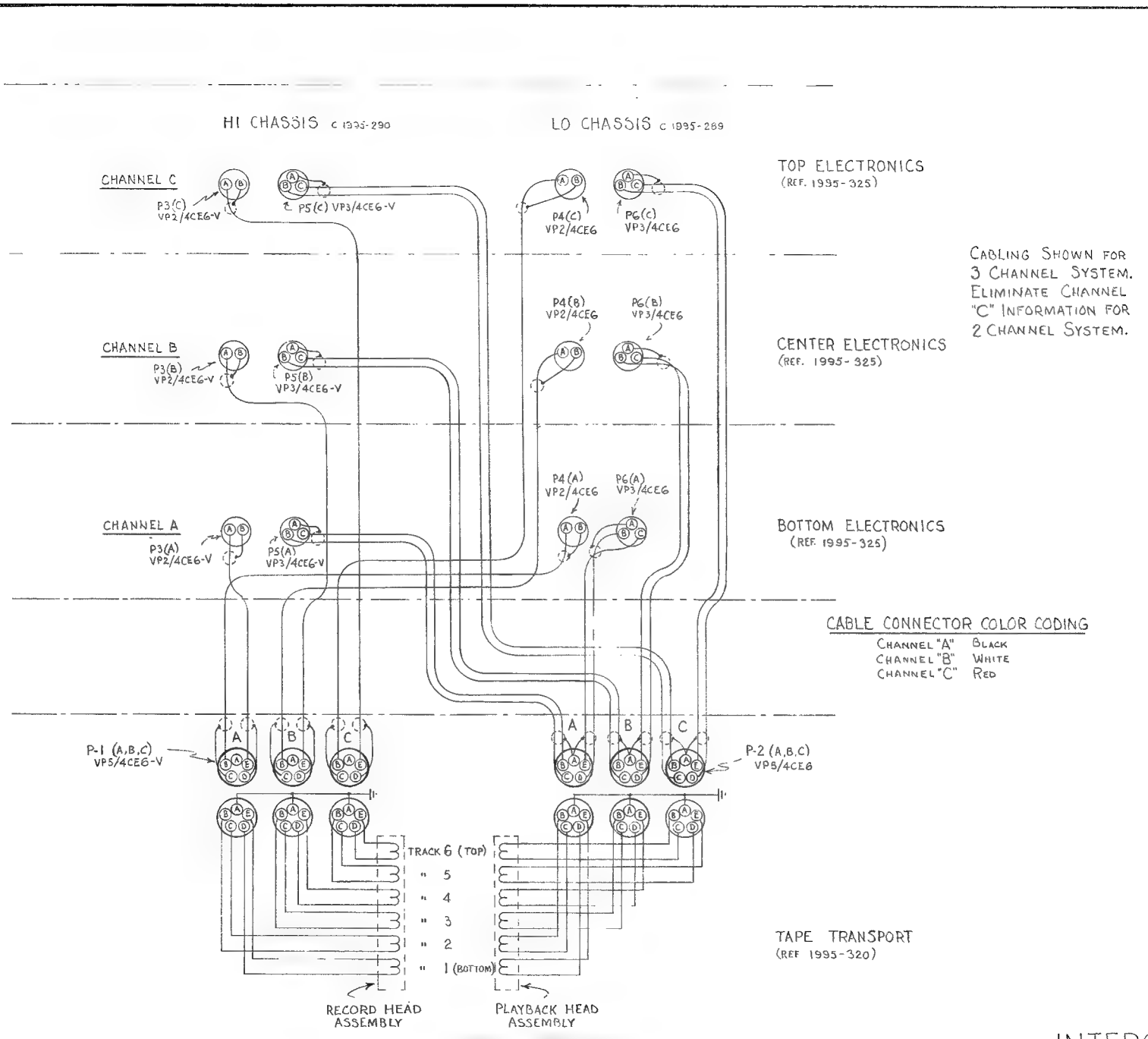
Power: Volts _____ Frequency _____ Cycles _____

Date checked: _____

By: _____



INTERCHASSIS
POWER CABLING



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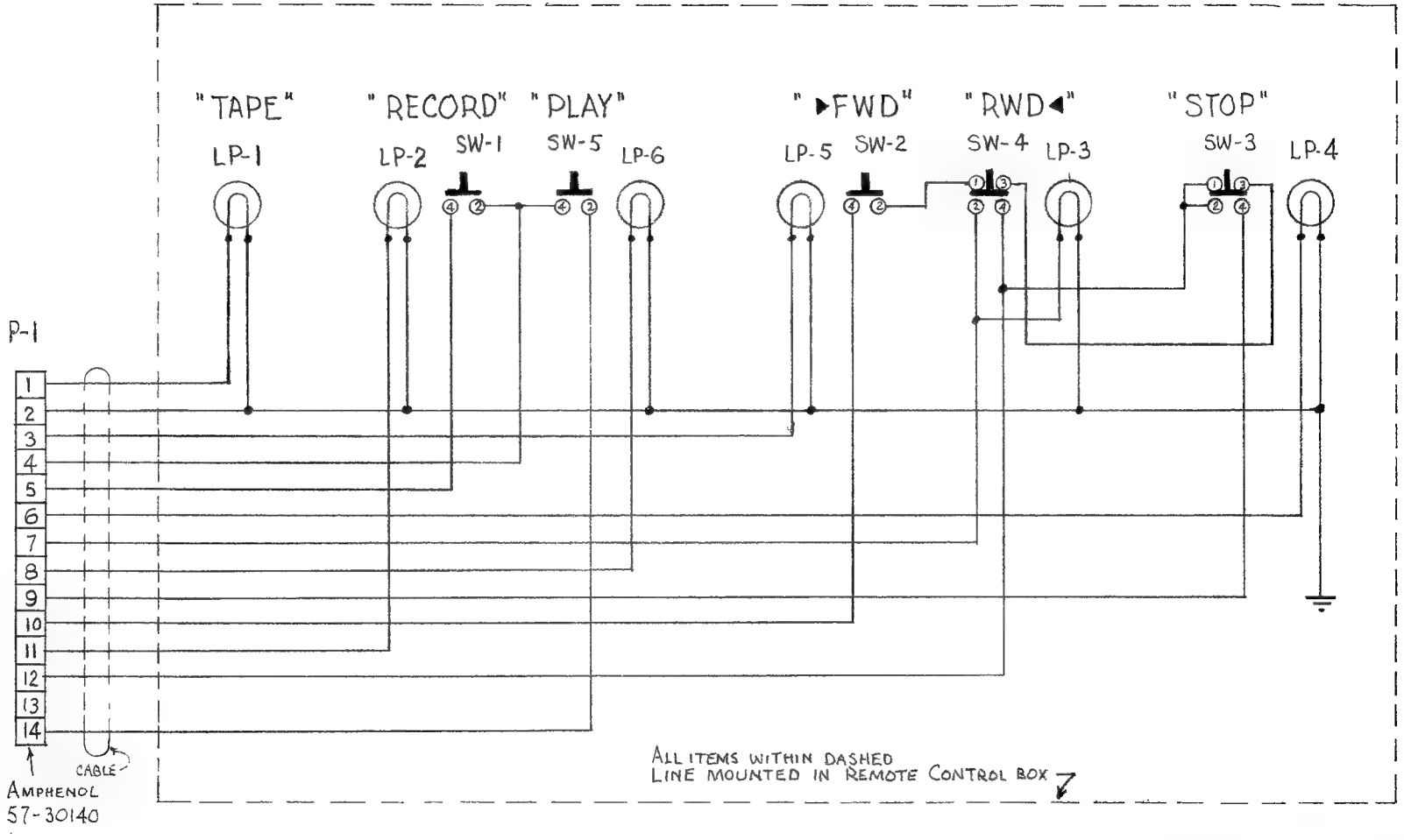
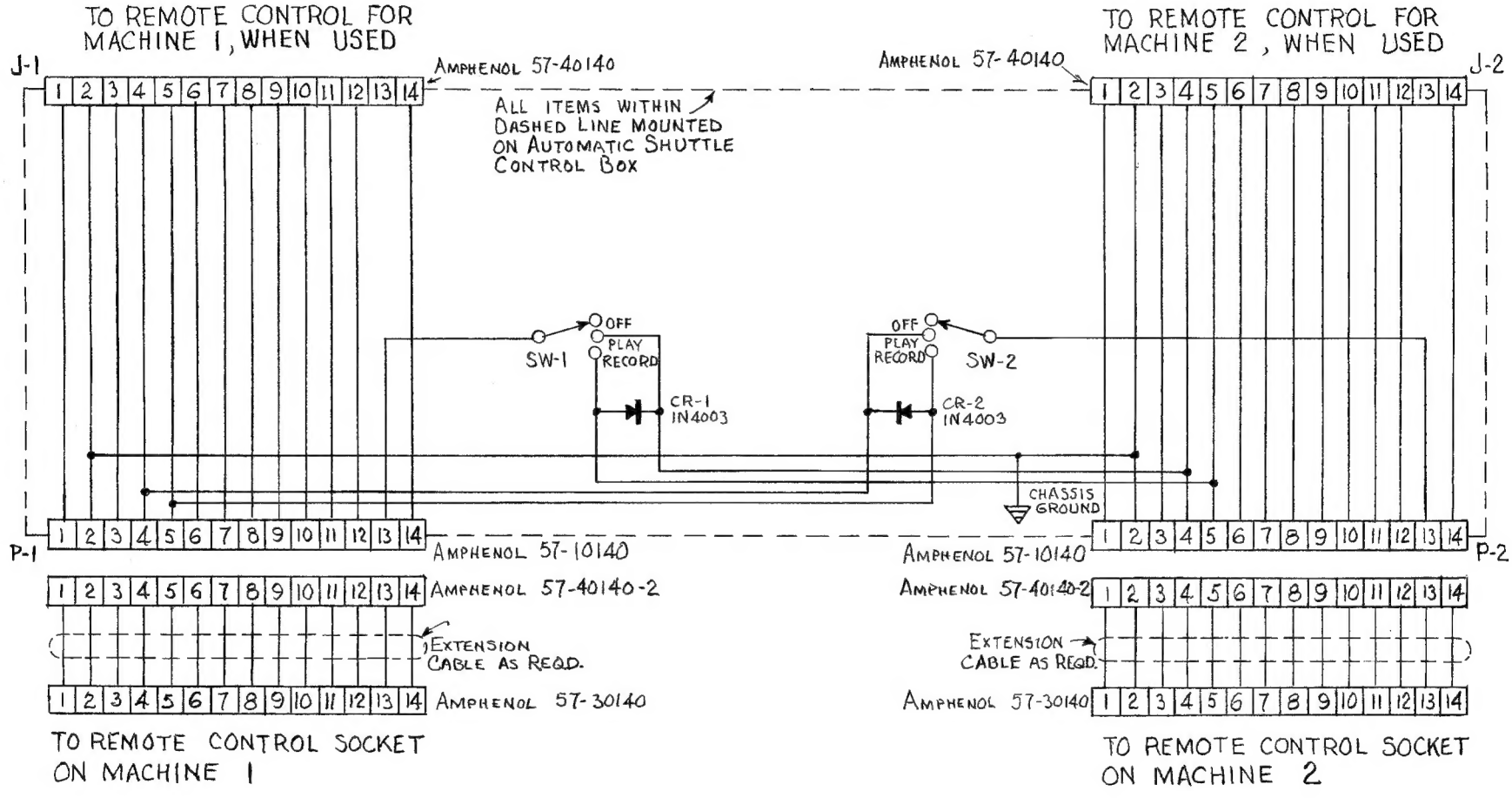


REMOTE CONTROL UNIT SCHEMATIC



AUTOMATIC SHUTTLE CONTROL SCHEMATIC

REMOTE CONTROL CONNECTOR

1 2 3 4 5 6 7 8 9 10 11 12 13 14 J-3

L M N P Q R S T D V W X Y Z

ELECTRONICS POWER

CHASSIS GROUND

MASTER OSC.

CAPSTAN SOLENOIDS

OUTGOING INGOING

"RECORD" "PLAY"

"▶FWD" "RWD◀" "STOP"

ITEMS INSIDE THIS LINE ARE MOUNTED ON BOARD 1995-319

ITEMS OUTSIDE THIS LINE ARE MOUNTED ON TRANSPORT MECHANISM

CO. K-1 REC. K-7 PRE. K-8 ACC. K-2 RUN K-3 FWD. K-4 RWD. K-5 STOP K-6

ELINCO MOTOR

BODINE MOTOR

"SPEED" SW-8

"POWER"

TO FAN IN PORTABLE MODEL ONLY

F-1 5AMP. SLOBLO 3AG

J-1

Q-1 2N1985

Q-2 2N174

REWIND MOTOR

TAKE-UP MOTOR

DOOR SOLENOID

LIFTER SOLENOIDS

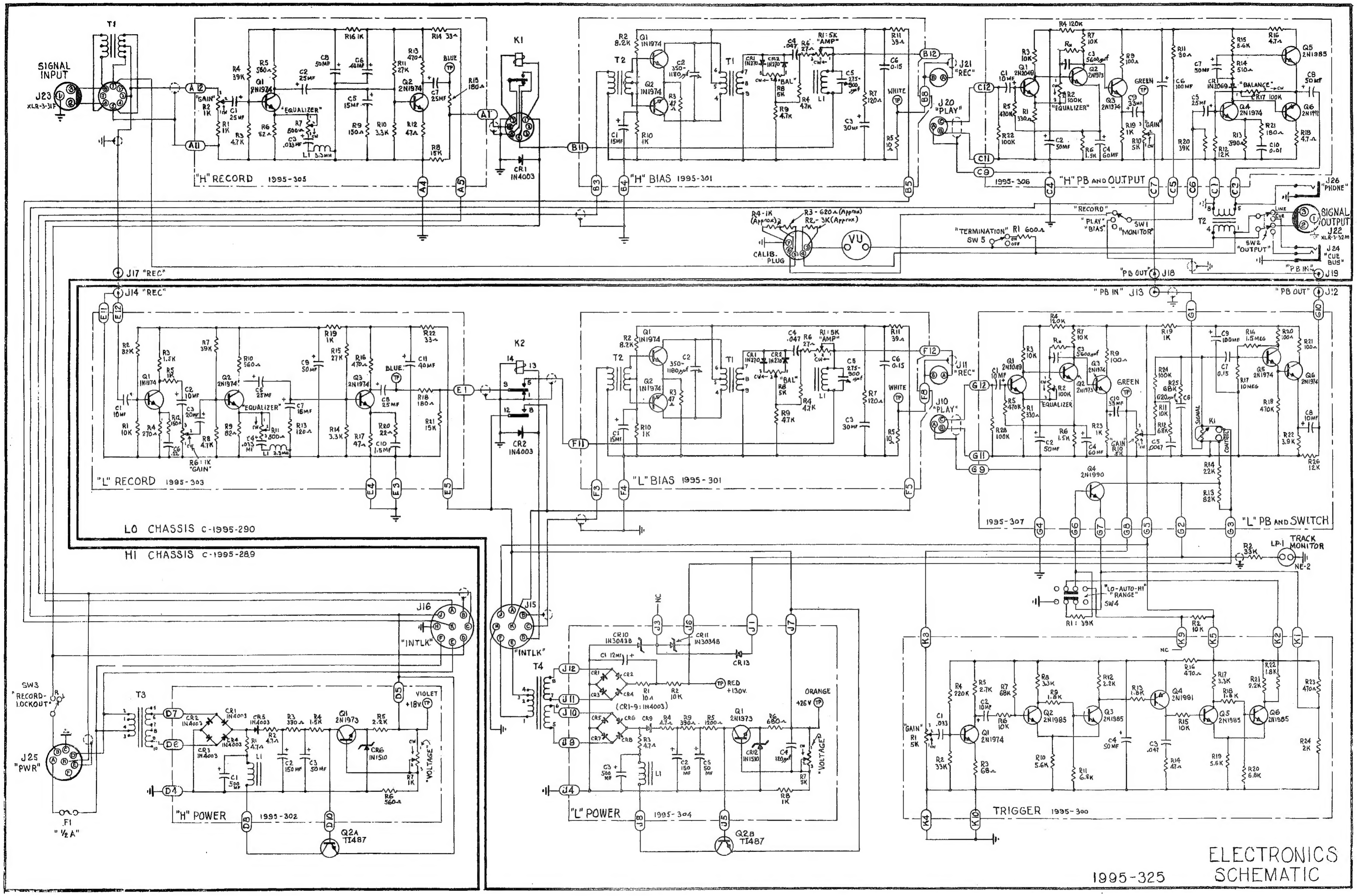
LOCK OPEN SW-10

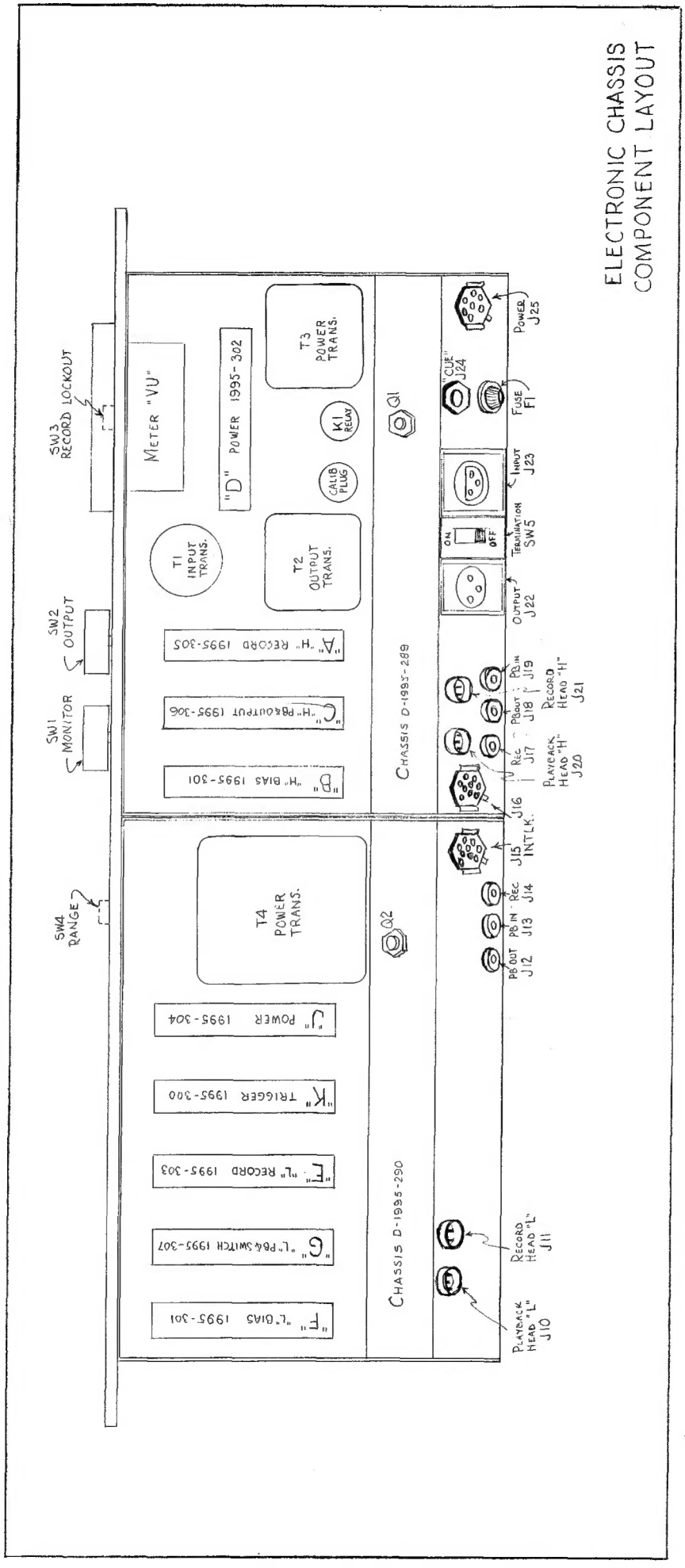
SW-7

SW-9

BAL. LARGE REEL

1995-320 TRANSPORT SCHEMATIC


SIGNAL INPUT
J23
XLR-3-31F
"H" RECORD 1995-305
"H" BIAS 1995-301
"H" PB AND OUTPUT
1995-306
J21 "REC"
J20 "PLAY"
J26 "PHONE"
SIGNAL OUTPUT
J22
J24 "CUE BUS"
CALIB. PLUG
VU
"TERMINATION" R1 600Ω
SW 5
"RECORD"
"PLAY"
"BIAS"
SW1
"MONITOR"
SW2 "OUTPUT"
J17 "REC"
"PB OUT" J18
"PB IN" J19
J14 "REC"
"PB IN" J13
"PB OUT" J12
"L" RECORD 1995-303
"L" BIAS 1995-301
"L" PB AND SWITCH
1995-307
J11 "REC"
J10 "PLAY"
K1
K2
LO CHASSIS C-1995-290
HI CHASSIS C-1995-289
TRACK MONITOR
"LO-AUTO-HI" "RANGE"
SW4
J16
"INTLK"
J15
"INTLK"
SW3 "RECORD-LOCKOUT"
J25 "PWR"
F1 "½A"
T3
T4
"H" POWER 1995-302
"L" POWER 1995-304
Q2A TI487
Q2B TI487
TRIGGER 1995-300
ELECTRONICS SCHEMATIC
1995-325


ELECTRONIC CHASSIS
COMPONENT LAYOUT
SW1 MONITOR
SW2 OUTPUT
SW3 RECORD LOCKOUT
SW4 RANGE
METER "VU"
"D" POWER 1995-302
T1 INPUT TRANS.
T2 OUTPUT TRANS.
T3 POWER TRANS.
T4 POWER TRANS.
CALIB PLUG
K1 RELAY
Q1
Q2
"A" "H" RECORD 1995-305
"C" "H" PB&OUTPUT 1995-306
"D" "H" BIAS 1995-301
"F" "L" RECORD 1995-303
"G" "L" PB&SWITCH 1995-307
"J" POWER 1995-304
"K" TRIGGER 1995-300
"T" "L" BIAS 1995-301
CHASSIS D-1995-289
CHASSIS D-1995-290
ON
OFF
TERMINATION SW5
INPUT J23
OUTPUT J22
"CUE" J24
POWER J25
FUSE F1
PB IN J19
PB OUT J18
REC J17
RECORD HEAD "H" J21
PLAYBACK HEAD "H" J20
INTLK. J16
INTLK. J15
REC J14
PB IN J13
PB OUT J12
RECORD HEAD "L" J11
PLAYBACK HEAD "L" J10